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THE ENGINEER

A Seven-Day Journal

New Year Honours

IN the first part of the New Year Honours List published on Tuesday, January 1st, the following names appear:—Mr. Winston Churchill receives the Order of Merit. Knighthoods are conferred upon Mr. Wallace Alan Akers, Director of Atomic Bomb Research, the Department of Scientific and Industrial Research; Mr. Donald Coleman Bailey, Acting Superintendent, the Experimental Bridging Establishment, the Ministry of Supply; Mr. William Valentine Ball, Senior Master and King's Remembrancer, the Supreme Court of Justice, and a valued legal contributor to THE ENGINEER; Mr. Thomas Penberthy Bennett, lately Director of Works, the Ministry of Works; Mr. Francis Joseph Edwin Brake, Controller of Construction and Regional Services, the Ministry of Aircraft Construction; Mr. Lawrence Edwards, lately Deputy Controller of Merchant Shipbuilding and Repairs, the Admiralty; Professor Charles Drummond Ellis, Scientific Adviser to the Army Council; Mr. Hubert Bryan Heath Eves, Chairman of the Tanker Tonnage Committee, the Petroleum Board, and deputy chairman of the Anglo-Iranian Oil Company; Mr. John Robinson Felton, H.M. Chief Inspector of Mines, the Ministry of Fuel and Power; Mr. Charles Frederick Goodeve, Deputy Controller of Research and Development, the Admiralty; Professor Ian Morris Heilbron, lately Scientific Adviser, the Ministry of Production; Mr. Norman Victor Kipping, lately Head of the Regional Division, the Ministry of Production; Mr. Benny Lockspieser, Director of Scientific Research, the Ministry of Aircraft Production; Commander Edward Robert Micklem, deputy chairman, Vickers-Armstrongs, Ltd.; Mr. Frank Ewart Smith, Chief Engineer and Superintendent, the Armament Design Department, the Ministry of Supply; Mr. William George Verdon Smith, chairman of the Bristol Aeroplane Company Ltd.; Mr. Thomas George Spencer, managing director of Standard Telephones and Cables Ltd.; Mr. Alexander Murray Stephen, chairman of Alexander Stephen and Sons, Linthouse, Glasgow; Major Robert Norman Thompson, chairman of Joseph Thompson and Sons, Ltd., of Sunderland. Engineer Vice-Admiral John Kingcome, the Engineer-in-Chief of the Fleet, becomes a K.C.B. Sir Cyril William Hurcomb receives the G.C.B., and Professor Archibald Vivian Hill, a Secretary of the Royal Society, becomes a Companion of Honour, in recognition of his scientific services. Professor Sir Edward Victor Appleton, Secretary of the Department of Scientific and Industrial Research, is awarded the G.B.E. Among the many C.B.E.s, the following may be mentioned:—Mr. H. W. Botting, chief engineer of the "Queen Mary"; Dr. S. F. Dorey, Chief Engineer Surveyor, Lloyd's Register of Shipping; Dr. P. Dunsheath, chief engineer and director of W. T. Henley's Telegraph Works Company, Ltd.; Mr. R. E. Peierls, Scientific Consultant on Atomic Bomb Research, the Department of Scientific and Industrial Research; the Hon. J. J. Denison-Pender, joint managing director of Cable and Wireless, Ltd.; Mr. A. J. Philpot, Director of Research and Secretary of the British Scientific Instrument Research Association; Mr. J. D. Pratt, Director and Secretary of the Association of British Chemical Manufacturers; Mr. W. G. Radley, Controller of Research in the Engineer-in-Chief's Office, the G.P.O.; Mr. C. G. H. Richardson, joint managing director of the Ransome Marles Bearing Company, Ltd.; Mr. J. Smith, chief designer, Vickers-Armstrongs, Ltd. (Supermarine Works); and Mr. G. R. Volkert, chief designer of Handley Page, Ltd.

Malayan Tin Mining Industry

A REPORT, submitted by Mr. A. D. Storke, Adviser to the Secretary of State for the Colonies, following his return from Malaya, states that the condition of the European tin dredging section is much better than was anticipated. Of the 126 dredgers which existed in 1941 only twenty-two, representing not more than 10 per cent. of the total capacity of the tin dredging industry, have disappeared. Providing that the necessary finance and manufacturing facilities are forthcoming, it is estimated that forty-one dredgers could be repaired by August, 1946, a further forty-six by June, 1947, and the remainder by the end of that year. The condition of the Chinese section of the industry is, however, worse than was expected. The power plants which supply electricity to the minefields are mostly in fair working order, but coal shortage may restrict the output of power and consequently the production of tin, unless the rehabilitation of the collieries at Batu Arang can be accelerated. About 70 per cent. of the former labour force is available, and Mr. Storke has drawn attention to the importance of making European staff and transport available, so that the labour force can be put to useful work. It is estimated that if the proposed repair programme is realised the production of tin in 1949 may amount to about 90 per cent. of the pre-war figure. The favourable position revealed by the report is further shown by the fact that Mr. Storke's estimate for the cost of rehabilitation is only a little more than half the estimate which was made before his visit to Malaya.

The Retirement of Mr. Robert Strachan

THE resignation of Mr. Robert Strachan from the joint managing directorship of the Fairfield Shipbuilding and Engineering Company, Ltd., which took effect at the end of the year, was referred to by Sir James Lithgow, the chairman of the company, at the recent launch of the "Tiger" class cruiser, H.M.S. "Blake." Mr. Strachan, who has served the firm for fifty-eight years, will retain his seat on the board. His son, Mr. George Strachan, has succeeded him as engineering director. Mr. Robert Strachan joined the firm as an apprentice at the age of fifteen, and in turn he became assistant chief draughtsman, chief draughtsman, assistant engineering manager, and engineering manager, with a seat on the board, in 1928, and joint managing director in 1937. His brother, the late Mr. George Strachan, started his career as a boy in the firm and became secretary and director, completing sixty years with the company. Sir James Lithgow said that they had been fortunate in securing the services of Mr. George Strachan to follow his father. Mr. George Strachan was educated at Allan Glen's School, Glasgow, and began his apprenticeship with the Fairfield Company in 1922. He spent a year with Sulzer's in Switzerland, and studied at the Glasgow University, taking his B.Sc. with distinctions in engineering and naval architecture in 1925 and 1926. He continued in the design and estimating departments of the firm until 1928, when he accepted a position with J. and S. Melling, Ltd., of London. In 1933 he was appointed engine works manager under his uncle, the late Mr. William Strachan, who was then the chairman and managing director of Workman, Clark (1928), Ltd. In 1935 he returned to the Clyde and joined Yarrow and Co., Ltd., at Scotstoun, as an assistant to the commercial director. In 1937 he was appointed engineering departmental manager of the firm. He remained at Scotstoun until April, 1945, when he was appointed engine director of the Fairfield Company and was given a seat on the board. From January 1st, 1946, Mr. George W. Barr became the managing director of the firm.

C. A. Parsons Research Appointments

IT is announced that C. A. Parsons and Co., Ltd., has appointed Dr. A. T. Bowden as the chief research engineer of the company, and Dr. J. M. Robertson as research metallurgist. Dr. Bowden graduated in engineering at Edinburgh University in 1923, and three years later took up a position as a lecturer in mechanical engineering at the University of Western Australia, where he was eventually appointed Associate Professor of Mechanical Engineering. While in Australia Dr. Bowden did much to further the design and application of gas producers for farm and road vehicles. He returned to this country at the beginning of the war and was appointed Assistant Director in the Department of Tank Design at the Ministry of Supply. In that position he was responsible for research, development, and the application of armour to fighting vehicles. He relinquished his post at the Ministry in October, 1945, to join the Parsons' staff. Dr. J. M. Robertson, who becomes research metallurgist, was a student at the Royal Technical College, Glasgow. He graduated in 1922, and was engaged in research and lecturing until 1926, when he was appointed research metallurgist at the Safety in Mines Research Board in London. In 1928 he became research assistant to Professor Sir Harold Carpenter and technical secretary to the Metallurgy Research Board of the Department of Scientific and Industrial Research, a position he held until the summer of 1939. On the outbreak of war his services were loaned by the Imperial College of Science and Technology to the Air Ministry, and he worked at the Royal Aircraft Establishment at Farnborough until March, 1941, when he was transferred to the Ministry of Supply. From that time until October, 1945, Dr. Robertson was employed in the Department of Tank Design on work connected with the control of the quality of tank armour. In October, 1945, he joined the Parsons' staff. These two new scientific appointments are part of a scheme of reconstruction which has been embarked upon by C. A. Parsons and Co., Ltd., in connection with which it is proposed to spend considerable sums of money during the next five years on the purchase of new equipment. The full programme envisaged will, we understand, amount to over a million pounds.

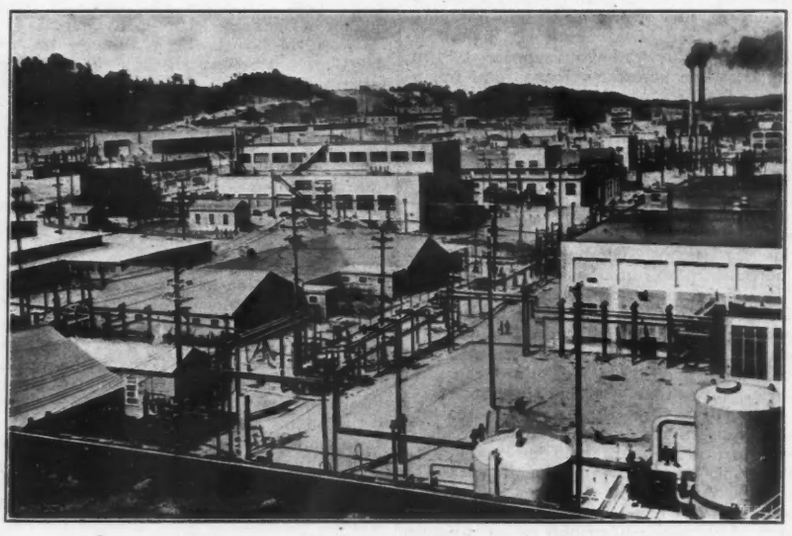
The Atomic Bomb

ON August 5th, 1945, a single United States aeroplane dropped one atomic bomb on Hiroshima and wiped out over 4 square miles of the city, or 60 per cent. of its area. On August 9th a second atomic bomb, said to be of an improved type, was dropped on Nagasaki. The destruction wrought by it was severe, but less devastating than at Hiroshima, partly, it seems, because the configuration of the ground afforded protection to some parts of the city.

On August 14th Japan surrendered unconditionally. It would be wrong, however, to assume that her surrender was dictated entirely by the threat of further bombing of the same kind. Even before the first atomic bomb was dropped Japan's position was desperate. Her Navy and her Air Force had been reduced almost to impotence, her Army was being driven in from one outpost after another, the invasion of her homeland was imminent, and Russia, freed from her struggle with Germany, had opened hostilities against her troops in North China. Militarily, the atomic bomb only hastened her inevitable end.

Nevertheless, to the world at large the news of the dropping of the bomb on Hiroshima brought a feeling of awe. It was at once realised that, working secretly and silently, science had succeeded in unleashing a new destructive force of terrible power, and of terrible significance for the future of mankind. Many people felt that it was a crime against humanity thus to exploit the most penetrating discovery science in the whole of its history has ever made. Undoubtedly, we must all feel regret that the achievements of so many brilliant investigators, the toil of so many workers, the expenditure of so much wealth, should have been applied in an apparently ruthless manner to the destruction of human life. There is, we think, little consolation to be found in the commonly expressed hope that the discovery of a means of releasing atomic energy will in time to come yield great benefits to man in his peaceful pursuits. Experience enjoins us not to be over-sanguine regarding an early realisation of that hope. It also teaches us that some of mankind's greatest inventions and discoveries are outstandingly warlike in their nature and have only a secondary value for peaceful purposes. The invention of gunpowder may be cited as one example, and the invention of the submarine is another.

The Hiroshima incident, and all that lay behind it, and all that, dimly at present, we can see may come of it, has undoubtedly disturbed many of our values and fixed ideas, both political and scientific. With the political aspects we are not directly concerned. Under this head all we need to say is that no one nation can escape the blame for the introduction of the atomic bomb or claim the credit for the scientific discoveries which made it possible. In 1939 all the principal belligerents-to-be—Great Britain, Germany, France, Russia, the United States, and Japan —were well aware of the possibility of producing a bomb based on nuclear fission. The essential scientific facts were common property and their transmutation into practical terms was only a question of time and the expenditure of sufficient industrial effort. It was a race against time between the United Nations and the Axis Powers. It is now known that thanks to the immense resources of the United States the race was won by the Allies. By what margin of time it was won will probably always remain unknown. It is, however, quite possible that it was only a question of months. Sooner or later, one side or the other would have produced an atomic bomb. There is surely room for much consolation in the fact that success came first to those who would not, and will not, use it as a means towards securing aggressive world domination.



THE CLINTON WORKS, OAK RIDGE, TENNESSEE

The scientific history of the atomic bomb is too long and complicated to tell on this occasion. We may, however, briefly set forth its industrial history, an aspect of the subject which goes back no farther than the year 1941. In October of that year, at the suggestion of President Roosevelt to Mr. Churchill, British and American scientists combined their efforts to solve the problems still to be faced before their laboratory results could be turned to account on an effective scale. A number of British scientists went to the United States to co-operate with those in America and Canada who had been studying the subject. By the summer of 1942 the progress made was so satisfactory that a decision was taken to proceed with the establishment of large-scale industrial plants. Three such plants were eventually set up, two of them being situated at Clinton, Tennessee, and the third at Hanford, State of Washington. Various considerations led to the selection of these sites. They had to be remote from the seaboard in order to reduce danger from hostile attack. At Clinton the works had at their command the electric power resources of the T.V.A., while the Hanford plant could draw upon the very pure water of the Columbia River. The photographs reproduced herewith and in a Supplement give some indication of the immense size of the establishments erected on these sites. It was necessary not only to erect the factory buildings, but also to provide housing, shopping, educational, and recreational facilities for the operatives and their families, all of whom were closely controlled in their movements in the interests of secrecy. Among other establishments directly associated with the industrial aspect of the atomic bomb, mention must be made of the plant at Los Alamos, New Mexico, where the processed material received from Clinton and Harford was finally assembled into bomb form and tested. It was at or near this site that the trial bomb was exploded on July 16th, 1945. An accompanying engraving reproduces six successive motion camera pictures of that explosion taken from a distance of 8 miles. The blast was felt as far away as 250 miles. In the sixth view a circular image is to be seen in the lower right-hand corner. It has nothing to do with the explosion, but is believed to have been produced by an internal reflection from the camera lens.

It is possible to give only a very brief account of the operations undertaken at the Clinton and Harford plants. Broadly, their object is the production of uranium 235, an isotope of the common form of uranium of atomic weight 238, and the production of plutonium, an artificial new element of atomic weight 239, produced from uranium 238 by neutron bombardment followed by radioactive disintegration. Uranium 235 and plutonium 239 are alternatives for the filling of an atomic bomb.

The raw material is black oxide of uranium, derived from pitch blende deposits found in Canada, California, and elsewhere. This oxide is converted chemically to uranium tetrafluoride or to potassium uranium fluoride. From either of these substances metallic uranium of a very high degree of purity is produced by an electrolytic process.

In its natural state the metallic uranium so obtained is a mixture of three isotopes. About 99·3 per cent. of it consists of U 238, 0·7 per cent. is U 235, and 0·006 per cent. is U 234. The practical problem lies in the separation of the small quantity of U 235 from the large amount of U 238. Since the specific gravities of these two bodies are proportional to their atomic weights, processes of separation dependent upon the difference of the densities naturally suggest themselves, although obviously the small difference between the two densities must make the separation difficult and tedious. It should be noted that the isotopes are *chemically* similar, and therefore that there is no possibility of separating them by any chemical process. At the same time the chemical compounds which they form,

although similar in their chemical properties, are characterised by the same difference of density as that existing between the isotopes. This statement, however, is subject to a proviso. Most elements with which uranium might be combined have isotopes of their own. It is therefore possible that a heavy isotope of the combining element might unite with the light uranium isotope, and *vice versâ*, and in such an event the difference in density between the U 235 and the U 238 compound would disappear, or even be inverted.

There is one element with which uranium combines which has no isotopes. That element is fluorine. It so happens that uranium hexafluoride at a slightly raised temperature is a gas. The molecular weights of U 235 hexafluoride and U 238 hexafluoride are 349 and 352 respectively, and it is on this difference that the separation processes employed depend.

One of these processes—it seems to be the one chiefly relied upon—is the gaseous diffusion method. Two gases of different densities diffuse through a porous partition at different rates. These rates are inversely proportional to the square roots of the molecular weights of the gases, and therefore the lighter gas will pass through the barrier more quickly than the heavier. Hence, after the passage the mixture which passes will be richer in the lighter gas than the proportion which does not pass. The enrichment depends upon the amount of the original mixture which is allowed to pass the barrier. In the case of uranium hexafluoride, if half the mixture is allowed to diffuse, the "enrichment factor" after one passage is 0·003. The smallness of this figure indicates the number of diffusion stages required to give a final product consisting principally of U 235 hexafluoride from a mixture which originally contains only 1 part in 140 of that gas.

In the gaseous diffusion equipment in actual use about 4000 diffusion stages are used, and the total area of the porous barriers runs into many acres. The gas leaving the last stage of the cascade is about 99 per cent. pure U 235 hexafluoride. At each stage the enriched gas passes on to the next, while the impoverished gas is returned to the feed of the next lower stage. The amount of gas forced through the first stage of the cascade is about 100,000 times the amount of the finished product leaving the last.

Of the other methods of isotope separation employed or studied, bare mention must for the present suffice. One comprised a process in which the gaseous mixture was passed through a series of separately driven high-speed centrifuges. For a production of about 2 lb. of U 235 per day, about 22,000 centrifuges, each 3ft. high, are understood to be required.

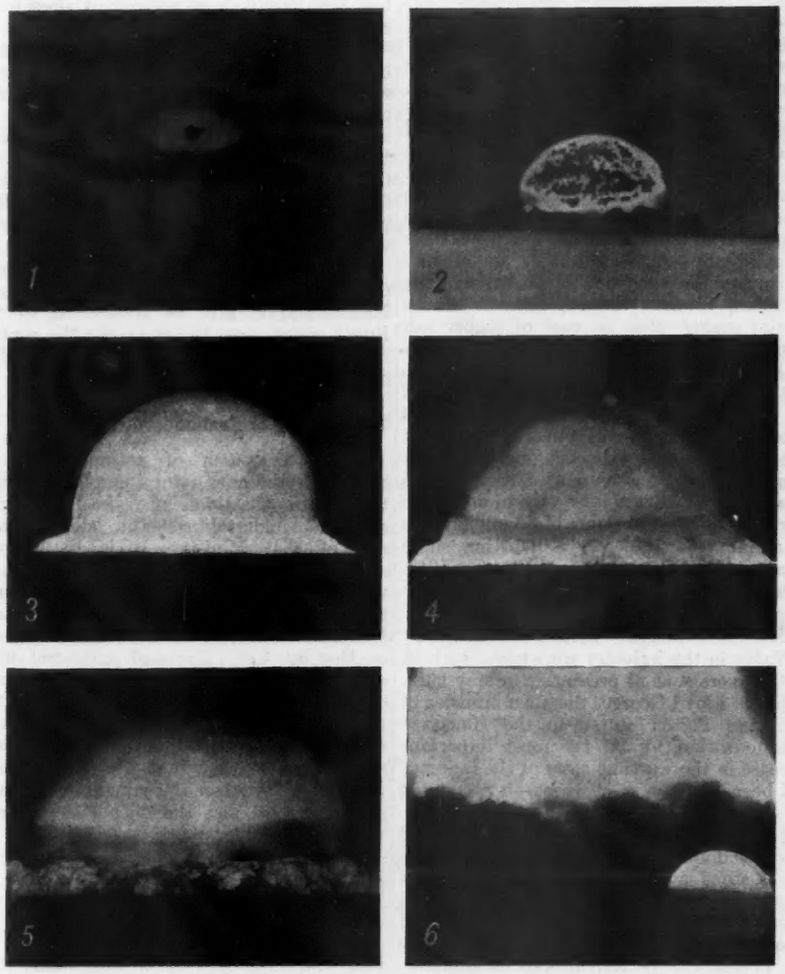
A third process is the thermal diffusion method. This process depends upon the fact that if a temperature gradient is established in a mixed gas, the heavier molecules tend to concentrate towards the cold end of the gradient. This method does not appear to have been used on a practical scale, except as a preliminary process for providing a partially enriched gas for a fourth separation process, the electro-magnetic process. The principle of this process involves the ionisation of the gas mixture to be separated and the acceleration of the ions by an electric field. The accelerated ions are then caused to traverse a magnetic field in which their paths become semi-circular, the paths of the lighter ions being of smaller radius than those of the heavier ions. With a correctly disposed slit, the lighter ions can be caused to pass into a collector, while the heavier are rejected.

The production of plutonium was centred at the Hanford plant, although a pilot plant was set up at Clinton. Details of the process followed at Hanford are vague, but something is known about those of the Clinton pilot plant process. The "raw material" is U 238 in the metallic form. This fact is of significance from the output point of view, since it means that a second outlet is provided for the metallic uranium from which U 235 is produced. The small amount of U 235 present in the metallic uranium from which plutonium is produced is not removed from it.

Slugs of uranium sheathed in aluminium jackets to protect them from corrosion are inserted in a "reacting pile"—a block of pure carbon in which holes are formed for the slugs and through which water (or helium) is passed to remove the large amount of heat liberated by the reaction. In the reacting pile the uranium is exposed to slow neutron bombardment from a radium-beryllium source. The reaction process involves nuclear fission, the rate of which is controlled by the movement of boron steel rods into or out of the pile.

The reacted material is pushed out of the pile into concrete tanks, where it is treated chemically. As delivered to these tanks the material consists of unreacted uranium, plutonium, or the intermediate product neptunium, and about thirty other elements formed as fission products from the U 235 present in the charge. These fission products are highly radioactive, and must be allowed to disintegrate into stable forms before they can be discharged to waste. The separation of the plutonium from the reacted charge is a purely chemical process, for since plutonium is a separate element and not an isotope of uranium, it reacts chemically in a distinctive manner.

The whole of the plant for the reacting pile and separation stages is shielded to protect the workers against radio activity, and is operated by remote control.



TRIAL BOMB EXPLOSION, LOS ALAMOS, JULY 16, 1945

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD.—The North of Scotland Hydro-Electric Board has now published its distribution scheme for the Gairloch and Aultbea district in North-West Rossshire. This, the Board's third distribution scheme has now been submitted to the Secretary of State for confirmation. The scheme, which was outlined in THE ENGINEER of February 16th, 1945, is planned to serve an area of 180 square miles round Loch Ewe and Loch Maree. With 52 miles of high-voltage and 36 miles of low-voltage distribution lines, it will make electricity available to over 95 per cent. of the total population of about 1600 in the distribution area. The electricity will be generated at a power station on the River Kerry. The generating station and reservoir form part of the Board's second constructional scheme, which included the Tummel-Garry project, and it therefore received the approval of Parliament along with the Tummel-Garry project last month. Completion of the work necessarily depends upon the availability of labour and material, but the Board will do all in its power to proceed with this scheme with the least possible delay.

Coal in 1945

By Sir RICHARD REDMAYNE, K.C.B.

No. I

THE past year will stand out as one of the most momentous in the long history of coal mining, for during it the Second Great War terminated (May 9th). The Coalition Government was succeeded in July by the most powerful—in so far as voting strength is concerned—Labour Government. The work of valuing the coal royalties, which were ceded to the Coal Commission as from July 1st, 1942, was completed. Proposals for the drastic reorganisation of the industry emanated from the industry itself (as well as intimated by the Government in large measure as the result of the report of the Technical Advisory Committee which had been set up in September, 1944, by the Minister of Fuel and Power to examine the present technique of coal production from coal face to wagon, and to advise what technical changes were necessary in order to bring the industry to a state of full technical efficiency). Still more drastic was the action of the Labour Government, which, upon its advent to power, proposed to carry out promptly the nationalisation of the industry. The Bill was printed a few days ago. During the year, also, the reports of the Regional Survey Committees began to appear, and by the end of the year many of them had been issued to the public.

Output

Working results for the complete year will not be available for some time, but those relative to production in respect of the third quarter of the year have appeared and point to a continuation in the downward grade. Thus :—

	Saleable coal produced, tons.	Output per man per quarter, tons.	Open-cast coal, tons.
1944 :			
3rd quarter ...	43,970,000	61·6	2,902,200
1945 :			
2nd quarter ...	43,687,400	61·1	2,207,000
3rd quarter ...	39,671,700	56·2	2,051,300

The loss in output, though in part due to the depletion in the number of miners available, is, in large measure, caused also by the high rate of abstention from work of those who are employed. Never in the history of the industry—since statistical information in this respect has been available—has absenteeism been so high as during the past year (a feature which has characterised the American coal mining industry also during the war period), yet the output per man-shift worked is, according to provisional figures, higher than in 1944, being now 1·03 tons. Speaking at Blackhall, on August 18th, Mr. Shinwell, the Minister of Fuel and Power, said he had set up a target of an additional 8 million tons in the next six months, and he proposed to place the responsibility for dealing with the problem of absenteeism upon the Miners' Lodges. In September, Mr. Arthur Horner, a prominent miners' leader, was appointed by the National Union of Mine Workers National Coal Production Officer, to co-ordinate the campaign to produce the extra 8 million tons of coal, but working through committees at the mines upon whom power was conferred to deal with habitual absentees. In the middle of December Mr. Shinwell spoke hopefully of the future, but, so far, hopes of securing a marked increase do not appear to be reaching fulfilment.

Quality

In point of quality the coal supplied has deteriorated. Mr. Harold Hobson, Chairman of the Central Electricity Board, speaking at the Fuel Luncheon Club on May 18th, stated that the fuels which had been delivered to power stations—which may be regarded as a fair sample of the whole delivered for national consumption—had not only shown a general deterioration in quality, but a quite inconsistent deterioration. It may be that, to some extent, the "open-cast" coal produced accounts for this, for coal so obtained is notably dirty, but it is a well-known fact also in coal mining circles that in times of great demand the coal marketed is not so clean as in times of depression; and yet the proportion of washed to unwashed coal has of late years been considerably augmented. Of course, the tendency must be, as time advances, towards the exploitation of the inferior seams—that is, coal of higher ash content—as those of better quality approach exhaustion.

It is heartening to notice a resumption in the exportation of coal, for Mr. Shinwell stated in the House of Commons (August 21st) that the coal exported during the six months ending June amounted to 1,028,955 tons. But we have a long way to go before we reach the pre-war figure of 52 million tons per annum (year 1937), and still further before we attain to the maximum, in the year 1913, of 98 million tons.

Cost and Wages

Wages in the industry were never so high on the average as at present. On May 29th, Major G. Lloyd George, the then Minister of Fuel and Power, stated in the House of Commons that by far the most important increase in the wartime costs of the industry had been in the form of wages—it accounted for two-thirds of the total increase—and, he added, that the price of coal at the pithead was then double what it was in 1939. Miners' wages stood at 12 on the list of industrial wage earners, compared with 81 in 1939. In wages a man-hour, however, they stood second, being higher than any other industry except motor, cycle, and aircraft manufacturing. The output had fallen by 50 million tons since the outbreak of war. Again, Mr. Shinwell informed the House, in reply to a question, that in the second quarter of 1945 the average cash weekly earnings of workers in the coal mining industry was £5 13s. 10d., as compared with £2 16s. 2d. in the corresponding quarter of 1939, or an increase of 95 per cent., and that there was a similar increase in the value of allowances in kind. That was, of course—as he stated—an average rate and applied equally to adults and juveniles. But it would appear to be an understatement. The earnings per shift have increased by 110 per cent. (from 11s. 11d. to 25s.) and, incidentally, the wages cost per ton by over 130 per cent. The reason why earnings per week had not risen with the earnings per shift is that absenteeism was two and half times as much as in 1939. Average earnings of adult coal-face workers are now approximately 29s. 6d. per shift.

The Coal Commission Report. Royalties and Amalgamations

The Coal Commission issued a report covering the period up to March 31st, 1945, which is an interesting record of the work accomplished.

The year 1945 witnessed the completion of the work of the Regional Valuation Boards, set up for distributing the compensation of £66,459,000 awarded by the Green Tribunal for the purchase of the unworked coal royalties. The total cost of the transaction is believed to have been under 3 per cent., which would appear to be a very reasonable figure. The total value of the 26,026 holdings amounted to £64,559,559, or some £2,000,000 less than the sum prescribed by Parliament. In addition, there has been allotted in respect of subsidiary coal hereditaments the sum of £182,455.

With regard to amalgamations of collieries, in view of the preoccupation of the industry with war production and to the general problem of the future efficiency of the coal mining industry, the Minister of Fuel and Power, as he announced in the House of Commons in March last, suggested to the Coal Commission that it would be justified in suspending its activities to promote individual amalgamation for a further period.

As most of the property and functions of the Coal Commission will, under the Coal Mines Nationalisation Bill, be transferred to the Board which is to be set up for the control of the Mines, the Coal Commission will be dissolved.

The Ministry of Fuel and Power

Under a system of nationalisation of collieries—and as a natural corollary thereto the nationalisation of the electricity and gas undertakings—the staffing and cost of that Ministry, it is to be presumed, will be greatly increased. Figures were forthcoming as to its present position in these respects by Mr. Peake, Parliamentary Under-Secretary, in the House of Commons on May 9th last. The staff numbered 3600, costing £1,190,000 exclusive of 1334 persons, costing £585,000, on the Opencast Coal Directorate. It is interesting to compare these figures with those of the Mines Department when stationed at the Home Office prior to 1920, when the mines were as safe as at present, and the output per annum vastly greater!

Regional Survey Reports

Regional reports of investigations on the coalfields were produced throughout the year, and the series must now be nearly completed. They will be of considerable value in regard to the reorganisation of the coal industry. The first of them to appear, if one excepts the report on Scotland, was that on the Durham field. The estimates of the available resources of coal in the various fields are brought up to date and afford valuable information. The Committee responsible for the Durham report, for instance, states that the coals of that field are "probably the most valuable in Europe"—referring to the coking and gas coals.

A Plan for Coal

In January, 1945, after visiting the several coalfields, inspecting collieries above and below ground, and discussing matters connected therewith with those chiefly concerned in the industry, owners, management, and men, Mr. Robert Foot, the newly appointed Chairman of the Mining Association of Great Britain, issued, what he termed, "A Plan for

Coal," being the report of the colliery owners. The late President of the Association, Sir Evan Williams, said that it was perhaps the first time that the public had been given an objective and unbiased picture of the eventful and turbulent part of the industry, and of providing Parliament with an alternative to nationalisation.

In April this report was followed by a supplement, being notes of a draft constitution and covenant, with proposals for an Arbitral Tribunal.

Under these reports the industry was to remain a free enterprise, the main departure from existing practice put forward being the establishment of a Central Coal Board "for the proper observance and maintenance by the industry itself of these principles" *i.e.*, the best possible ways of mining the coal; maintenance of the highest state of efficiency; non-closing of collieries unless all practical arrangements have been made for the employment of the men elsewhere; consideration to be given to housing, transport, and welfare of the men; progressive selling of coal; elimination of unnecessary distribution charges; the ensuring to the workmen of a fair wage and stability; continuity of employment and a good standard of living; a reasonable return to the owner on the capital employed in the industry, &c., "and any others (principles) that may be established from time to time as governing principles for the operation of the industry." This Central Coal Board was to be presided over by a full-time Chairman, and was to be composed of not more than fifteen members, drawn from the industry. The Chairman was to be appointed by the Mining Association. The "plan" was approved and accepted by the colliery owners, representing over 95 per cent. of the coal output of the country. In the supplementary report the criticisms of the main report were considered and answered, *e.g.*, non-representation thereon of the consumers, and the fact that insufficient emphasis had been placed upon the importance of amalgamations. To meet these and other criticisms, Mr. Foot proposed an Arbitral Tribunal to be constituted by Parliament as the ultimate authority to decide disputes. But there still remained the inherent weakness that neither the coal consumers, the Coal Commission as the owners of the coal, nor the workmen were to be represented on the Central Board.

(*To be continued*)

Armoured Fighting Vehicles of the War

By SIR CLAUDE GIBB

SHOULD the full story of tanks and other armoured fighting vehicles of the 1939–45 war ever be told, it will be one of desperate efforts to make up for the tragic neglect from the end of the 1914–18 war until the outbreak of the last war. Only those intimately connected with the full problem can appreciate just how completely lacking was this country in basic design information and how desperate were the efforts made to rectify such shameful neglect. As one who only came into the picture at a late stage, when the bulk of the basic work had been done, it is possible to look back dispassionately on the efforts of one's predecessors and review with satisfaction the developments which alone were possible from the efforts, and in some cases the mistakes, of those who had previously been in charge. In this regard it is an extraordinary thing that, whereas few touchline critics have claimed to be capable of designing aircraft or guns, so many engineers, politicians, and soldiers have regarded themselves as heaven-born designers of tanks, and acted as virulent and generally unconstructive critics of those making such desperate efforts to recover our position.

Due to the fact that practically no development of armoured fighting vehicles was carried out in the twenty-one years between the two wars, the Army had not had modern tanks—in fact, hardly any tanks—with which to exercise and work out tactics or even to make the wildest guess at what equipment would be required in the event of another European war. The soldier is trained for war and not for design and production. Hence it seemed impossible for him to realise that the time interval between demanding a new form of tank and the first one reaching the Army must be a minimum of two years, even though the whole energies of the country's designers and builders be devoted to that one project.

FIG. 1—BRITISH ARMY TANK OF 1939-40

Even at the close of the present war and after 5½ years of fighting experience, there still were wide divergences in opinion in the Army as to what form of tanks they wanted. Some commanders maintained that two entirely different types of tank were required, one being the relatively slow, heavily armoured, big-gunned tank which would be used for assault purposes when the enemy was dug in behind minefields and well prepared and defended positions. Once those heavy tanks had penetrated the defending line, then the next class of tanks, the lighter, faster, less heavily armoured and smaller-gunned, tanks, would go through the gap, and, by attacking the enemy rear lines of communication, would cause a complete withdrawal of the whole defended front. It was this policy which gave rise to the classification of the "Infantry" tank for the first type of operation and the "Cruiser" tank for the second. But there was, and still is another school of thought from commanders which maintains that operations cannot be properly carried out unless there is one common tank to do both the "break in" and the "break through." In other words, flexibility of utilisation of equipment is immeasurably improved by having a common tank for both *rôles*, and there is no doubt that life for the commander is greatly simplified if he has such tanks.

Designers, whilst receiving general direction from the recommendations of the commanders in the field, do seek advice on detailed matters from all ranks of the Royal Armoured Corps, and in such discussions find both admirable clarity of thought and many misconceptions. Probably the finest advice that the tank designers ever received was from a Major who had risen from the ranks and been awarded a D.S.O. for brilliant tank fighting, which was given in the following words:—"First, I want to be able to go from A to B, but be able to return to A hurriedly if I receive a bloody nose. Hence, reliability is essential. Next, I want to be able to hold the other fellow off by having a long-reach gun. Then I do not want to get my face smashed up if I am hit, and so want a nice thick, comforting slab of armour in front of me. I do not mind so much being hit in the kidneys or legs. If, to obtain reliability, the long-range gun, and a thick slab of armour in front of my face, I have to accept thin flanks, then it is my job to fight my tank so that I do not expose my thin sides." That advice was followed as closely as possible in later designs of British tanks.

Tank critics generally completely overlooked the fact that from 1940 onwards it was inevitable that were we to win this war we must as soon as possible conduct an offensive series of battles and that the enemy must be put on the defensive. It was realised that for some time to come our armies must continue to fight defensive battles whilst equipment was being designed, produced, and built up in quantities to allow the switchover to the offensive. Were it possible to design and manufacture equipment overnight, there would have been no problem, since industry would at first produce defensive equipment, and then, by waving the magic wand, switch over to offensive equipment when the armies changed their *rôle* and the attack began. This, however, was not possible, and offensive equipment had to be produced, although defensive battles were still being fought.

These armchair critics also lost sight of the fact that when an army is retreating it destroys bridges, railways, and roads after it has withdrawn its heavy equipment, and

the advancing army must then bridge rivers and canals, repair railways and roads before it can follow up the retreating army with anything other than the lightest equipment. The critics who advocated the heavy tank as a means of winning the war more quickly and avoiding tank casualties, did not realise that our superb bridging equipment was designed primarily to take a 40-ton load of a specified maximum width, and it is a fact that had the British Army been equipped with 60–80-ton monsters for advances or the initial assault, they would not have been able to cross the various rivers and canals which formed natural defence lines for the retreating enemy. It is of interest to note that up to V.E. day, there was not a single bridge in the British area across the Rhine capable of taking a heavier load than a 40-ton tank, so that had we concentrated part of our tank productive effort on heavy assault tanks they would still have been on the wrong side of the Rhine by the date the complete surrender of the enemy took place.

FIG. 2—"VALENTINE" INFANTRY TANK

The foregoing is not an apologia, but an explanation to the uninformed.

Fig. 1 shows the tank which was taken to France in 1939 and 1940, the tank with which the British Army entered the war. In 1939 it was not in great favour, yet it was believed at least to be fightable. Its armament was a 0·303 machine gun, and its speed some 6–8 m.p.h. It had to fight against German tanks mounting a 50 mm. gun, and it literally was suicide to stand up to the enemy. Fortunately before the war broke out design work had been proceeding on a tank which, in the hands of the troops became famous for its reliability and general qualities. This was the "Valentine," shown in Fig. 2. So much start, however, had the enemy in tank development, that the "Valentine," despite its many advances and its fine quality, was soon outgunned, and our troops, quite naturally, demanded better tanks.

The "Valentine" was in the class known as the "Infantry" tank, and was relatively slow, with a maximum speed of about 16 m.p.h. At about the same time the "Crusader" tank (Fig. 3) reached the battle area, and this was of the "Cruiser" class, with a much more powerful engine and a road speed approaching 30 m.p.h. The "Crusader" had an excellent suspension, but it used an engine adapted from an aircraft design used in the 1914–18 war, and it suffered many mechanical defects, due to the lack of large scale testing, inevitable under war conditions. The sand problems of the desert had to be experienced to be believed, let alone appreciated, and the importance of air filtration, which had not shown up in testing under European conditions, soon became a major item in desert reliability. The "Crusader," whilst being a great advance on anything previously handled by our troops, was again being outgunned and again came the demand for more armour and a bigger gun.

Desert fighting had stressed the need for mobility and speed, and it was inevitable that in the design of the "Cromwell" (Fig. 4), which was to be a "Cruiser" tank, replacing the "Crusader," ability to meet desert conditions was uppermost in the designers' minds. The "Cromwell" was 50 per cent. heavier than the "Crusader," and, as originally produced, had a maximum speed just short of 40 m.p.h. The "Cromwell" was the tank that contributed so much to the 450 miles advance from south of the Seine to Antwerp in 8½ days, when the enemy was completely demoralised by the speed of our armour, and the advance made at an amazingly small cost in casualties either to life or equipment.

FIG. 3—"CRUSADER" CRUISER TANK

The story of the "Churchill" tank has been largely told in Parliament and the Press. It is a story of achievement for which full credit has never been given. To go into production straight from the drawing-board on a tank weighing 40 tons and carrying armour thicker than had ever been previously contemplated, was a decision calling for wonderful courage. It can be, and has been, argued that time would have been saved had the more normal course of building and testing prototypes been followed before embarking on large-scale production. As one who was not a party to that bold decision to go straight into production, but who subsequently was able to study all the facts and to review the results, it can be stated quite emphatically that the decision was the correct one, and that, in fact, it saved at least a year in giving to the troops a tank which, despite certain defects, did wonderful service and turned the tide of battle in our favour on many, many occasions. Only those closely associated with the development of the "Churchill" can know of the heartbreaks which the designers and producers suffered, and the superhuman efforts which ultimately resulted in "that thick-skinned monster" known as the heavy "Churchill," and shown in a Supplement page.

The "Cromwell" and its outstanding performance was only made possible by its engine. Again, the non-availability of an engine designed specifically for tank work necessitated the adoption of a proven aero-engine of suitable overall dimensions and power. Had money been available between the two wars for the development of suitable engines, the designers would not have been so tragically handicapped in meeting the legitimate demands of the fighting troops. Those who were intimately connected in the struggle to catch up the long years of start which the enemy possessed feel very bitter on this question of the non-availability of any proven component necessary to produce a successful tank. It is hoped that this country will not repeat the tragedies of the past and will permit development of engines, transmissions, suspensions, and the other components essential to armoured fighting vehicle construction.

With a 600 H.P. engine available and a tank weighing just below 30 tons, giving a power/weight ratio of 20 H.P. per ton, things really began to look brighter in the

tank world. But the performance of the "Cromwell" brought its own penalties in suspensions, tracks, and those other components which received greater punishment by virtue of the improved performance. Disaster followed disaster in development testing, but each hurdle was surmounted as it came along, and ultimately the "Cromwell" achieved a reliability at least equal to the "Churchill."

From the "Cromwell" to the "Comet" (see Supplement) was a relatively easy jump, because by that time sufficient fundamental data had been accumulated to enable the majority of the factors governing design and performance to be accurately forecast. The "Comet" went straight into production off the drawingboard, but, whereas it was nearly four years from the inception of the "Churchill" to large numbers being in the hands of the troops, it was less than two years between the commencement of "Comet" design and its first brigade of tanks going into battle. The "Comet" established itself immediately as the ideal tank for the chase, and it did magnificent work from the crossing of the Rhine to V.E. day. Its bigger gun, its heavier armour, its magnificent reliability, its improved sighting, and grand performance made it the tank the troops had waited for so long.

But the story is not fully told, nor, in fact, can it be as yet. Fig. 5 shows a "Heavy Assault" tank, which was a development of the "Heavy Churchill," but with even thicker armour and a much bigger gun. It was completing its tests when V.E. day came, and troops of long experience who had seen it and handled it were enthusiastic. This new "Heavy Infantry" tank, which was given the name "Black Prince," had completed its acceptance trials in one year from the first discussion regarding its possibilities.

Four years for the first "Churchill," but one year for the last. Such was the speed possible when basic information and experience existed. Without continued development, there must inevitably be tragedy repeated should the world ever be foolish enough again to go to war. It is not possible to disclose other than by name particulars of the "Battle Cruiser" tank "Centurion," which also was a miracle of development, and which, when sent to Germany, brought forth one criticism only—"just too late." In performance, in fire power, in armour, and in reliability, it had "everything plus" that the troops required.

But tanks were only a proportion of the armoured fighting vehicles which the Army required and had. There were "Swimming" tanks, "Wading" tanks, "Concrete-Breaking" tanks, "Anti-Mine Flail" tanks, "Bridging" tanks, "Flame-Throwing" tanks," "Command" tanks, "Observation" tanks; in fact, it seemed that there were tanks of every conceivable description.

FIG. 5—"BLACK PRINCE" HEAVY INFANTRY TANK

In addition, however, there was the big range of self-propelled guns, which were basically tanks, although used entirely differently. Their true description was "the mobile artillery of the Army." The problems in their design were every bit as complex as in the fighting tank. They wanted mobility, armour protection, the big gun, but also wanted ease of concealment (which, incidentally, the tank wanted also), and a refinement of fire control which is the tradition of the "gunner."

There were also armoured cars, which were vital to reconnaissance and any advance of the army. These had to carry quite respectable guns, and, in fact, at the end of the war the gun of the armoured car was much bigger than the gun of our earlier tanks. They had to have the highest possible mobility, outstanding reliability, armour protection, and, in fact, were a light tank on wheels. There were also "Scout" cars, which had to carry a machine gun, and to give armour protection to the crew against small arms fire from the enemy. The maid of all work of the British armies was the carrier, and it also had problems of design parallel to many of those in other armoured fighting vehicles.

FIG. 4—"CROMWELL" CRUISER TANK

The major lesson which must be learned from the experience of this war is the truth of the old proverb "You cannot make bricks without straw." You cannot design successfully any intricate engineering mechanism without sufficient basic data and experience to provide a solid starting point in development. Tank designers were handicapped almost right out of the race by the absence of a suitable power unit. It is not generally appreciated that space and weight limitations for the engine of an armoured fighting vehicle are every bit as vital as with the aircraft engine. The design of a tank engine must be such that accessibility for maintenance is reasonable, since maintenance can only be carried out between actions, and generally when the crew are dog-tired and eager to snatch some food and sleep. The perfect tank engine would give unlimited power for zero space occupied, and only by continued development, trial and service experience can the engine of minimum space occupied with maximum power and suitable torque characteristics be evolved. The engine used with such outstanding success in later British "Cruiser" tanks basically was a derated aircraft engine, on which it is estimated no fewer than 100,000 hours of development testing had been spent.

The primary function of the tank is to proceed reliably from A to B so that *en route* and on arrival at B it may kill—or, much the same thing, be in the position to kill—infantry. To this end it has been called upon to an ever-increasing degree to defend itself against heavy attack from tank and anti-tank guns, and so perforce has had to mount a gun of ever-increasing fire power and as much armour for protection as reliability, speed, and fire power will permit. Quite obviously, these are competing requirements, and there is hardly a single aspect in

tank design which in one way or other does not clash with other aspects. The result of these clashes is that the final design can never be better than a compromise, and any compromise leads to differences of opinion. If it is remembered that there is no parallel in industry to the relatively high speed yet very heavily tracked armoured fighting vehicle, it will be appreciated that there is no industrial experience from which to draw for the design of the tank. Hence, development facilities specifically for fighting equipment must be maintained and utilised vigorously if we are to keep in the forefront in such matters and to give the designers even a reasonable chance of meeting the accelerated demands which war, or the fear of war, inevitably bring.

Aeronautics in 1945

No. I

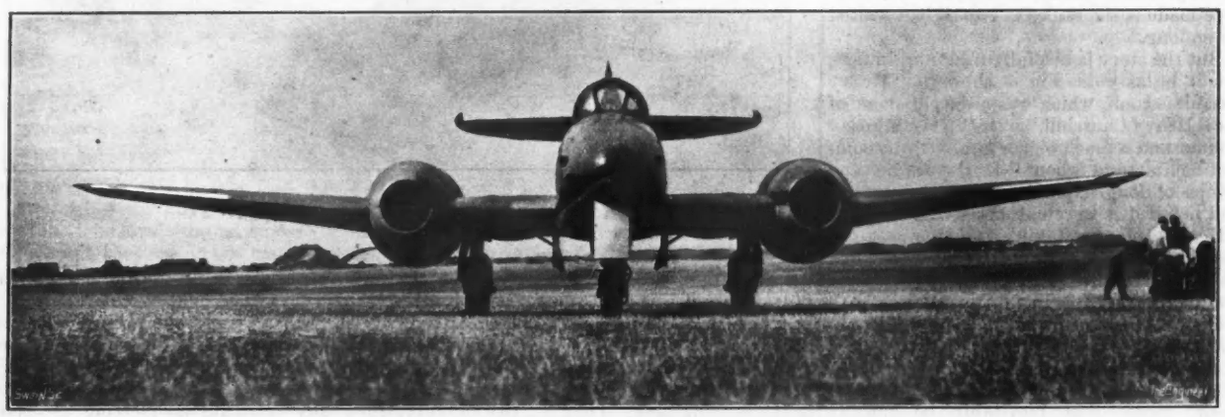
Military Aircraft

HAD hostilities lasted a little longer than they did, we would undoubtedly have seen the introduction on a large scale by all the belligerants of some striking developments in the design of military aircraft, notably a rapidly increasing employment of jet propulsion for both bombers and fighters. As it was, the wars ended before these developments could be fully deployed, with the result that the aircraft in use during 1945 were in the main simply advanced types of those in service or about to go into service in the autumn of 1939. In this country, for instance, we continued to the end to place main reliance upon the "Lancaster" and "Halifax" bombers, "Sunderland" flying boats, and "Spitfire" and "Mosquito" fighters, all of them of pre-war origin, although by successive modifications they had been greatly improved in performance. The "Hurricane" fighter had dropped out of the running, but its place had been taken by two direct descendants, the "Tempest" and the "Typhoon."

In normal peacetime circumstances a period of about five years is generally considered to be the average interval elapsing between the conception of a new design and its production in quantity. In wartime an impetus towards shortening that interval exists, but it is counteracted by other factors, and on the whole it is probable that the interval remains much the same. Thus the wars ended at a time when an influx of new designs, begun as a result of operational experience in their earlier stages, was due and was taking place. From the information released concerning these new aircraft, it might be possible to obtain some idea of the probable trend of design during the next few years. Any deductions under this head must, however, be qualified by a large measure of uncertainty following the introduction of the atomic bomb. The world is at a solemn moment in its history. If, unhappily, the efforts now being made to restrict or outlaw the use of that terrible missile should fail, the consequences for humanity will be dire. Incidentally, the whole future of military aircraft design will be greatly affected. With a single light aircraft able to carry as much destructive energy as was released during a "thousand-bomber" raid in the late hostilities, bombers and bombing tactics as we have known them will become outmoded. And if instead of transporting the atomic explosive in an aircraft it is, as it might well be, carried in a long-range rocket, the interceptor fighter class of aircraft will become archaic.

In these circumstances we have the strange spectacle of military aeronautical design ready to reap all the fruits of six years of war experience and to enter a new phase in its evolution, and yet hesitating to commit itself lest the coming of the atomic bomb should render all improvements obsolete before they can be brought fully into service.

The year may be said to be chiefly notable as marking the fulfilment of the prolonged efforts to apply the jet propulsion system successfully to military aircraft. In this country chief public interest was focussed on the Gloster "Meteor" and the de Havilland "Vampire" jet-propelled fighters. Other firms, notably the Bristol Company, are, however, known to be well advanced with the development of similar aircraft The Gloster "Meteor" IV on November 7th at Herne Bay set up a new world speed record by travelling at an average of 606 m p.h. on four runs over the trial course. The previous internationally recognised record was 469 m.p.h., and was held by Germany. The "Meteor" IV is in operational service with the R.A.F. as a single-seater fighter, and is driven by two Rolls-Royce "Derwent" V jet engines. During the record-breaking flight the engines were not allowed to develop their full power. The flight is, in fact, claimed to have been made under almost "cruising" conditions. The performance of the "Vampire" has not yet been officially disclosed. It is driven by a single de Havilland "Goblin" jet engine, and its speed is stated to be in the neighbourhood of 540 m.p.h. A naval version of the "Vampire" has been produced.

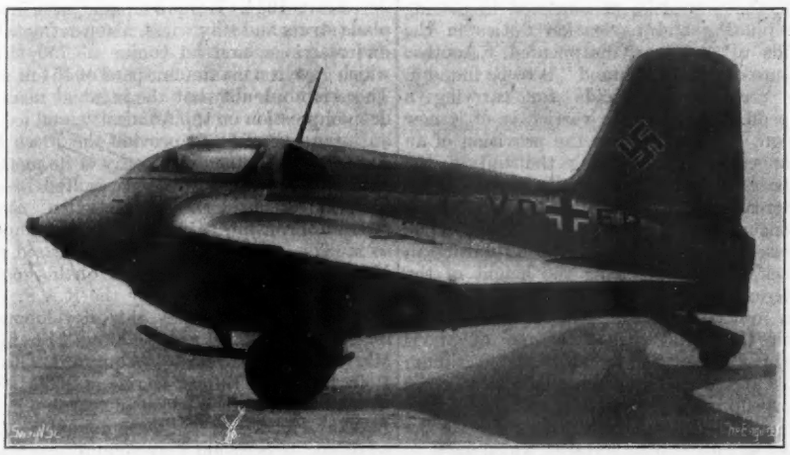


GLOSTER "METEOR" SINGLE-SEAT JET-PROPELLED FIGHTER

Little is known concerning other British jet-propelled aircraft now being developed, but it may be surmised that this country is not lagging behind the stage of development reached in Germany at the end of the war. How far the enemy had proceeded with jet propulsion was fully disclosed by the Air

ME 262A SINGLE-SEAT JET-PROPELLED FIGHTER

Ministry in a document released in September. Germany made an early start on jet-driven aircraft. Her first machine of this class to be flown was a small single-seater Heinkel, the He 178, which made its first flight on August 27th, 1939, four days before the Germans precipitated the war by marching into Poland. This aircraft was driven by a Heinkel turbo-jet unit, developing a thrust of only 1000 lb. It was used purely for experimental purposes, and from it there was developed a twin-jet fighter, the He 280 which flew in 1941, but did not show any great promise. In 1939 the Messerschmitt company also began work on jet propulsion, and by 1941 was ready with the Me 262 single-seater fighter driven by two Heinkel jet engines. A year or so later the Heinkel units were replaced by Junkers jet engines and a programme of intensive development was begun. At the end of the war this machine had been developed to give a top speed of 525 m.p.h. at 23,000ft., and a service ceiling just short of 40,000ft. It carried four guns, and could, if required, take a bomb load of up to 1000 lb. It proved to be the enemy's most useful type of jet-propelled aircraft.



ME 163B ROCKET-PROPELLED INTERCEPTOR

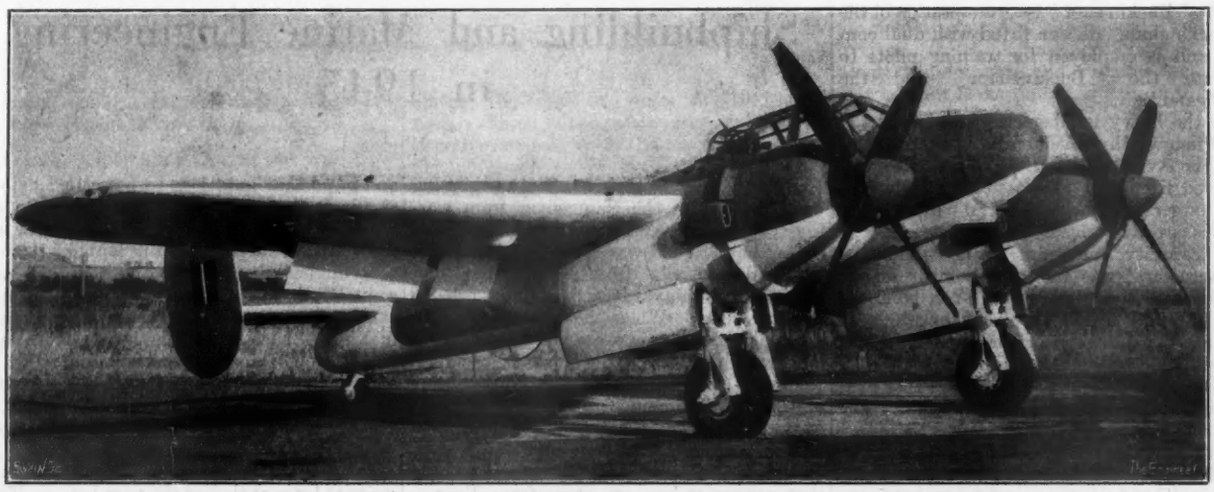
The Germans also made serious efforts to develop the jet-propelled bomber. One design which was flown towards the close of hostilities was the Arado 234C, fitted with four BMW jet engines. It had a speed of over 540 m.p.h., and was possibly the fastest bomber in the world. An even more powerful jet-propelled bomber was almost ready for service, when the enemy collapsed. This was the Junkers 287, fitted with six BMW jet units. This aircraft was designed for a range of 1175 miles with a bomb load of 3 tons. Its maximum speed was over 530 m.p.h.

In addition to jet-propelled fighters and bombers, the Germans paid much attention to rocket-propelled aircraft, mainly interceptors with very short duration of flight. One such which came into service several months before the end of hostilities was the Me 163, or "Komet." This small machine had a level speed of some 550 m.p.h., and could climb to 30,000ft. in just over 2½ min. It took off under its own power, jettisoned its wheels, and landed on a skid. A later development of this design was equipped with a subsidiary rocket unit to give economy at cruising speeds. Under full power this aircraft had an endurance of 12 min., and a maximum speed of 590 m.p.h. A still more remarkable rocket type of interceptor was being developed when fighting ceased. This was the Bachem BP 20, "Natter." It had a span of only 18ft., and was driven by a single liquid rocket. It was to take off vertically with the aid of auxiliary rockets, climb at a rate of about 37,000ft. per minute, and attack a hostile bomber with rocket projectiles. The pilot was then to be ejected and to descend by parachute. Simultaneously, the rear half of the fuselage containing the liquid rocket was to break off and also descend by parachute.

Among other developments, the enemy, when the war ended, was working on a jet-propelled dive bomber, and on a helicopter with the vanes rotated by jet propulsion.

In this country information was released after the German collapse regarding several recently introduced aircraft with orthodox engine and propeller drives. One of the most interesting of these machines was the Westland "Welkin" stratosphere single-seater fighter, designed to deal with high-flying raiders. This aircraft has an armoured pressure cabin and carries four cannon. With its wing span of 70ft., it is the largest of the single-seater fighters. It is driven by two Rolls-Royce "Merlin" engines, each developing 1650 H.P., great power at high altitudes being maintained by means of two-stage, two-speed superchargers. The cabin pressure is automatically maintained by a valve arrangement at the correct value without attention from the pilot. To overcome ice and mist formation on the windscreen at the heights at which the aircraft may be called upon to operate, the windscreen—as well as other parts of the cabin—is formed of two layers of glazing between which warm air is pumped. It is stated that the cabin-heating arrangements are such that even when the external temperature is as low as — 78 deg. Fah. the pilot need not wear special clothing. No information is available concerning the service ceiling of the "Welkin," but its speed is stated to be 385 m.p.h., and its range about 1500 miles.

A single-seater long-range fighter which may be regarded as a development of the "Mosquito" is the de Havilland "Hornet." The fuselage of this machine is of wood, and the wings are of composite wood and metal construction. The engines are "Merlins," and drive de Havilland four-bladed propellers running in opposed directions. The armament consists of four 20 mm. cannon in the nose. The speed is said to be over 470 m.p.h., the range, with extra tanks, upwards of 2500 miles, and the ceiling about 35,000ft.



BRISTOL "BRIGAND" COASTAL COMMAND STRIKE AIRCRAFT

Among the aircraft which would doubtless have come into extensive military use had hostilities been prolonged would have been three types of Bristol machines, the "Buckingham," "Brigand," and "Buckmaster," all of which represent developments of the Bristol Company's "Beaufighter," an air-

craft which in the earlier days of the war rendered good service as a night fighter and as a land-based torpedo bomber. The "Buckingham" was designed in 1941 as a fast day bomber, carrying a crew of four. The navigator-air-bomber occupies the rear-most station within the fuselage, and has access to a nacelle in the floor having the aiming panel and bombsight at the forward end and a two-gun turret at the rear. This turret commands the field of fire behind and below the tail. The air gunner's dorsal turret is equipped with four Browning guns which can be rotated through 360 deg. and elevated through a range of 85 deg. Between this station and the pilot accommodation is provided for a radio operator. In addition to the turret armament there are four fixed Browning guns commanded by the pilot and firing ahead in the line of flight. All the crew stations are protected by armour plating. The aircraft is driven by two "Centaurus" engines fitted with "Rotol" fans for ground cooling. The fuel is carried in six flexible tanks designed to give protection against 20 mm. cannon fire, and having a total capacity of 1050 gallons. The aircraft has a speed of 330 m.p.h. at 12,000ft., a service ceiling of 25,000ft., and a full load range of 2000 miles at 200 m.p.h.

By the time the "Buckingham" was in quantity production, the development of Radar navigational aids had greatly improved the effectiveness of our night bomber raids against Germany, while for daylight attacks the "Mosquito" was proving highly successful. The need for an additional day bomber had therefore disappeared, and the "Buckingham" was adapted as a high-speed courier, carrying four passengers and a crew of three.

The Bristol "Brigand" is a faster edition of the "Beaufighter," and has the same wings and tail unit as the "Buckingham." It carries a crew of three and is driven by two "Centaurus" engines. It belongs to the "strike" class of aircraft used by Coastal Command and carries torpedoes and rocket projectiles. In addition, it is an effective fighter, and is fitted for use as a dive bomber.

The "Buckmaster" is an adaptation of the "Buckingham" design fitted with dual control and is employed for training pilots to operate the "Buckingham" and the "Brigand."

In the heavy bomber class of aircraft the most noteworthy development in this country was the Avro "Lincoln." This aircraft was evolved from the "Lancaster," of which it is a larger and more powerful edition. No details are available regarding its speed or load capacity, but from the fact that the "Lancaster" was the only bomber in the world which could carry a 10-ton bomb, it can be gathered that we ended the war with a bomber of quite exceptional capacity in our possession. So far as we know, however, its advent was too late to permit it to be used against either Germany or Japan. The "Lincoln" is driven by four "Merlin" engines. It is very heavily armed for a British bomber, its defensive equipment consisting of seven 0·5in. machine guns distributed between four stations. The only other particulars of the aircraft which have been released are its leading dimensions:—Span, 120ft.; length, 78ft. 3½in.; height, 17ft. 3½in.; wing area, 1421 square feet; weight, about 75,000 lb.

On the naval side a notable addition to our forces was the Blackburn "Firebrand," Mk. IV, a single-seater strike aircraft, designed to carry all forms of offensive armament, including a torpedo. It was developed from an earlier "Sabre"-engined model designed as a naval fighter. All the available "Sabre" engines were required for the Hawker "Typhoon" fighter, and, further, the "Seafire," then coming into full production, promised to provide the Navy with a fighter of high performance. It was therefore decided to convert the original "Firebrand" to a strike aircraft, and to redesign it to take a Bristol "Centaurus" engine. The resultant aircraft is notable because of the fact that it is a single-seater. Immediately preceding designs of naval machines of this class had been multi-seaters, but with the developments made in Radar and other navigational aids, the difficulties encountered in placing the piloting and navigation duties in the hands of one man disappeared. Another feature of the "Firebrand" is to be found in the arrangements made for carrying a torpedo. The torpedo carrier is of a new design, characterised by the provision of an arrangement for lowering the tail of the torpedo after the aircraft is in flight and the undercarriage has been retracted. This arrangement enables the torpedo to be released at a much higher speed during an attack, and by reducing the height of the undercarriage effects a considerable reduction in the overall height of the aircraft. With the "Centaurus" engine of about 2500 H.P., the "Firebrand" has a maximum speed at sea level of 320 m.p.h., and carrying a torpedo can climb at a rate of 2200ft. per minute. It is fitted with dive breaks on the upper and lower wing surfaces, which increase the normal drag some two or two and a half times, and limit the speed during a dive to about 350 m.p.h. The wings are arranged to fold to facilitate storage of the aircraft on a naval carrier and are fitted with hydraulically operated slotted flaps to increase the lift at take-off. The defensive armament consists of four 20 mm. guns mounted two in each wing, and electrically controlled from the cockpit.

The "Firebrand" clearly reveals the great advance which took place during the later years of hostilities in the design of naval aircraft. Whatever may be said of the R.A.F. machines with which we began the war in 1939, it cannot be denied that our naval aircraft were capable of being greatly improved. It may be recalled in this connection that as late as February, 1942, when the "Scharnhorst," "Gneisenau," and "Prinz Eugen" escaped from Brest, and, passing up-channel, succeeded in reaching ports in Germany, our initial attack from the air was made by six naval "Swordfish" aircraft, all of which were shot down. This type of aircraft was designed as a Fleet torpedo-bomber—or a strike aircraft, as it is now called—and dated from 1934. It was a biplane, with interplane struts and stay wires, a non-retractable undercarriage, and an engine of 750 H.P., which gave it a maximum speed of 154 m.p.h. There is no doubt that the incident made a deep impression on the Admiralty, and led to an intensive effort to provide the Fleet Air Arm with aircraft more worthy of its mettle.

The change then initiated resulted before the war ended in the production of naval aircraft of constantly improving performance, so much so that before hostilities ceased the Navy possessed aircraft of a quality comparable with those flown by the R.A.F. In the naval fighter class this development reached a high level in the Fairey "Firefly," Mk. IV. This aircraft is equipped with a Rolls-Royce "Griffon" engine of 2300 H.P., which gives it a top speed of 386 m.p.h. at 14,000ft. It carries four 20 mm. guns, and in addition, as occasion may require, can take sixteen rocket projectiles, eight heavier rockets or bombs up to 1000 lb. With long-range jettisonable tanks, it has a radius of action of 1400 miles.

In the latest version of the "Seafire"—the Mk. XV—the Royal Navy now possesses an even faster fighter, the top speed being 400 m.p.h. This aircraft—descended from the land-based "Spitfire"—is armed less heavily than the "Firefly." It carries two 20 mm. cannon and four 0·303 machine guns, and can carry a 500 lb. bomb.

(To be continued)

Shipbuilding and Marine Engineering in 1945

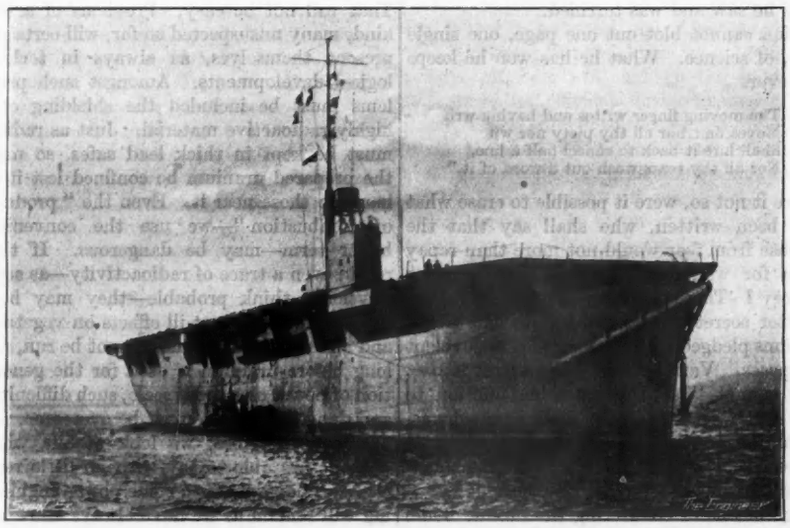
No. I

DURING the year under review a beginning was made in the changeover from war-time to peace production, and with the cessation of hostilities it was found possible to lift the veil partially from much that had happened in shipyards and engine works in the war years. When the Lloyd's Register shipbuilding returns were again published last September, it was shown that close upon 1,500,000 tons of merchant shipping were under construction in British shipyards. The work now in hand will, we are informed, ensure good employment for eighteen months or two years, and it is satisfactory to note that among orders are some from France, Norway, Belgium, Holland, Portugal, and the Argentine. British shipowners, however, naturally hold back from placing all their orders, owing to the still outstanding settlement of questions of tonnage replacement, and the overhanging uncertainty with regard to the future of the large surplus of American-built ships and those vessels ordered by the Government and run by the Ministry of War Transport. Although it seems unlikely that there will be any Government step in the direction of the nationalisation of shipping, there are still many controls to be removed, and important questions to be settled before steady replacement of special tonnage, much needed by shipowners, can be made. At the present time the price of ships is about 100 per cent. higher than before the war, and not a little of this increased cost is directly caused by increases in the prices of basic materials, such as coal, iron, steel, and timber, most of which are still controlled in some way, to which has to be added the very high cost of transport, which throughout the war has been fixed by the Government.

The output for the year will be found to be not quite as large as that of the year before. This reduction was caused by the slowing down of the programme of warship construction and the refitting and conversion of merchant ships. Trawlers have had to be reconverted for fishing purposes, and merchant ships and aircraft carriers have had to be refitted for trooping, while in the case of other ships war fittings have had to be removed. All this work has interfered with the normal work of the shipyards and repair establishments. In most of the shipyards and engine works, however, the changeover has now been made, or is in process of being carried out, and it

will not be long before commercial work can be resumed to the fullest extent.

This smooth changeover has been made possible by the character of our merchant shipbuilding programme during the war, which, unlike those of America and Canada, was at no time one of "volume." The British programme was largely concerned with the design and construction of special types of ships for war transportation purposes, which was continually changing. At one time ships had to be prepared for Arctic sea conditions, while later the same ships and others had to be modified in order to enable them to operate successfully under tropical conditions. This varied work exercised to the full the shipbuilding experience and skill, and the knowledge of marine engineering in all its branches, which we had acquired in the years in which we had held the enviable position of the major shipbuilding country of the world. The future will not be without its difficulties, but this knowledge, coupled with greater co-operation of firms for the common good, learned during the war, should go far in solving them.



MERCHANT AIRCRAFT CARRIER "EMPIRE MACALPINE"

Merchant Shipbuilding During the War

An event of the year was the paper on "Merchant Shipbuilding During the War," given by Sir Amos L. Ayre, the Chairman of the Shipbuilding Conference, and until the beginning of the year Director of Merchant Shipbuilding and Deputy Controller of Merchant Shipbuilding at the Admiralty, before the Institution of Naval Architects. Part of that paper was reprinted in THE ENGINEER of April 20th and 27th. Sir Amos described the technical formulation of the wartime merchant shipbuilding programme, and the many special ships, such as standard cargo carriers, large and small tankers, fast cargo liners and tankers, crane ships, merchant aircraft carriers with grain or oil cargoes, and the many small ships, such as prefabricated tugs, barges, and small naval craft. Not a little of this special work was carried out by land firms, and works and structural engineers' yards outside the shipbuilding industry. There is room for further special papers on many of these developments, and it is to be hoped that fuller information will be published, thereby completing the picture and giving technical information which will be most useful to the industry. Labour in the shipbuilding industry in 1945 was not without its difficulties, but the number of strikes were fewer than in the previous year. Throughout the country many shipyards and engine works were definitely understaffed and apprentices and skilled workers were often taken away by the Ministry of Labour or called up for national service. The supply of labour has fallen off, and, as after the last war, there will be competition with the housing programme for the services of such workers as plumbers, painters, joiners, electricians, and cabinet makers. These questions will demand the careful attention of the Minister of Labour and other departments concerned, if shipbuilding is to do its best for our much-needed export trade.

Merchant Aircraft Carriers

In the course of the year the Admiralty released particulars of the merchant aircraft carriers, which played such an important part in policing the Atlantic Ocean during the difficult years of 1942 and 1943. These ships were essentially fleet aircraft carriers, with the maximum capacity of cargo, either grain or oil, in large holds or tanks below the second deck. The hangar space was provided between the second deck and the flight deck or on some of the converted tankers the aircraft were stowed on deck with protective screens. Ample spares and stores were also carried. These ships of the grain-carrying type were designed by the Burntisland Shipbuilding Company, in conjunction with the Merchant Shipbuilding Department of the Admiralty, and the first ship laid down in August, 1942, was delivered to the Admiralty in April, 1943. An illustrated description of the ships appeared in our issue of November 9th last, and a view of the "Empire Macalpine" is reproduced herewith. The overall length is 448ft., with a beam of 57ft. and a depth from keel to flight deck of 53ft. The flight deck is 442ft. long with a width of 62ft. The deadweight-carrying capacity is 7930 tons, and the gross tonnage 7950. Single-screw Doxford opposed-piston oil engines of 3400 S.H.P. give a designed running speed of about 13 knots.

Another similar development took place on the tanker side, which was proposed by and entrusted to Mr. John Lamb, the manager of the technical division of the Anglo-Saxon Petroleum Company. The first of nine tankers chosen for this work were sent to a Tyneside yard in February, 1943, and the conversion was completed five months later. Within twenty-one months of the first report being sent to the Ministry of War Transport, the nine ships chosen for conversion were in commission. These ancillary aircraft carriers, it is now known, played a most important part in the winning of the Battle of the Atlantic. The ships from the Anglo-Saxon fleet so converted included the "Rapana," "Amastra," "Alexia," "Adula," "Gadila," "Marcoma," "Ancylus," "Miralda," and "Acavus." Most of this work was carried out by Smith's Dock Company, Ltd., Palmers (Hebburn), Ltd., and T. W. Greenwell and Co., Ltd.

Whaling Factory Ships

Noteworthy among the large ships completed during the past year were the whaling factory ships "Southern Venturer" and "Norhval," built for British and Norwegian ownership by the Furness Shipbuilding Company, of Haverton Hill-on-Tees. One of these ships is shown in to-day's Supplement. At the time it was decided to proceed with a large programme of whaling factory ships, these particular vessels were being built as large fast tankers. Plans were immediately carried into effect for their conversion, and both ships were completed in record time. They have now reached the Antarctic whaling grounds. Each of them has a length of 535ft., with a breadth moulded of 74ft., a depth to flensing or weather deck of 57ft., and a loaded draught of 34ft. 6in. The gross tonnage is 14,066, and the displacement 32,383 tons. The cargo tank capacity is 19,760 tons, and some 2300 tons of oil fuel are carried. The propelling machinery consists of twin-screw, triple-expansion, North-Eastern Marine steam engines, taking steam at 220 lb. pressure from eight Scotch oil-fired boilers, which also provide the steam for factory use. In our issues of December 7th and 14th we gave a full description of these interesting ships, and made reference to the boilers for rendering down the blubber and the special plant for dehydrating whale meat and extracting liver oil. In the "Southern Venturer" this plant was designed and supplied by Rose, Downs and Thompson, Ltd., of Hull, while the liver oil plant in the "Norhval" was designed, supplied, and erected by George Scott and Son (London), Ltd. A second whaling factory ship is now under construction at the Furness yard for Chr. Salvesen and Co., of Leith, the owners of the "Southern Venturer"; while at the Belfast yard of Harland and Wolff, Ltd., a whaling ship is under construction for United Whalers, Ltd., of London. She is well advanced and will embody new features in hull design and factory equipment. Just before the end of the war a German refinery ship, the "Unitas", was taken over by British owners and renamed the "Empire Victory." She was repaired at Belfast and re-equipped with factory plant at Falmouth, and she sailed for the Antarctic. In the late autumn two Norwegian-owned whaling factory ships, the 22,000-ton Furness-built "Sir James Clark Ross," and the smaller "Thorshammer," sailed for the South Antarctic from New York.

(To be continued)

TIN STOCKS IN MALAYA.—The Ministry of Supply announces that a revised estimate of stocks of metal tin found in Malaya is now available; the figure now reported is 4500 tons. Details of stocks of tin ore are not yet available.

The Engineer

JANUARY 4, 1946

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A Retrospect

FOR as long as Earth shall endure, 1945 will be known as the year of Atomic—or more precisely, Nuclear—Energy. The historical events, the coming of peace in Europe and the Pacific, the death of Mr. Roosevelt, the defeat of the Conservatives and the triumph of Labour at a General Election, and the American loan, will drop into their places in tables of dates for the students and schoolboys of the future. These are all passing things; pictures in the phantasmagoria of history. They will have made their mark and faded into the complex of the past. But the utilisation of nuclear forces will remain. The economy of the world will be as surely changed by it as it was by steam. We are now entering on the Atomic Age, just as two hundred and fifty years ago we entered the age of steam with Newcomen's atmospheric engine.

Never was a scientific discovery more remarkable and more deplorable. Whilst it remained the grail of physicists, the Himalayan peak of scientific endeavour, the splitting of the atom had a peculiar and especial charm. Entering into the very ultimate essence of matter, it presented itself as the unsurpassable end of all inquiry; one knew not what mysteries would be revealed or what demons released from the outraged atom. But when the search passed from the fairyland of Science, when it left the laboratory and entered the factory, it encompassed man with terror. Seeing what a mere pound or two of a fatal material could achieve in the utter desolation of several square miles of Japanese city and dockyard, man perceived that he had now near to his hand the means of destroying the whole world and of giving back, in an instant, to "chaos and old Night," a fabric which it has taken untold millions upon millions of years to build. This he saw and was terrified.

Man cannot blot out one page, one single line, of science. What he has won he keeps for ever.

> "The moving finger writes and having writ
> Moves on: nor all thy piety nor wit
> Shall lure it back to cancel half a line,
> Nor all thy tears wash out a word of it."

Were it not so, were it possible to erase what has been written, who shall say that the release from fear would not more than repay man for what he may gain from nuclear energy? There has been talk of keeping the matter secret, of reserving it to but a few nations pledged never to use it for malevolent purposes. Vain desire! The secret is out. We cannot "lay the flattering unction to our souls" that its use by man for the devastation of man and his works can be for ever arrested. It must remain a constant menace unless in the still further advances of knowledge means of countering the atomic bomb shall be found. Even then, like a "fleet in being," it will remain a terrifying spectre which cannot be exorcised and against which preparations have to be constantly ready. So it must ever be unless—that is our greatest hope—it forces man by the very magnitude of its possibilities to live in good will with his neighbour.

Industrial Nuclear Energy

Let us turn now from this spectacle of a frightened world to a world which sees in nuclear energy a beneficent force that, properly applied, can make happier man's lot upon earth by the reduction of unpleasant tasks and the increase of those material things that we call amenities. Rumours apart, there is as yet no evidence that we are close to the industrial utilisation of this new source of power. Stunts there may be in the near future; single, excessively costly, demonstrations of the harnessing of the atom. But it is not rash to prophesy that years must pass before the nucleus of matter becomes a competitor with existing sources of power. There was talk during the past year of the folly of pursuing schemes for hydraulic power development or enlarging electric generating stations. Such talk betrays a lack of knowledge of the history of technical progress. Furthermore, it overlooks the fact that a vast amount of power must be provided for the preparation of the materials—whatever they may ultimately be—from which nuclear energy is derived. Those materials cannot be won from the earth like oil or coal and be ready with but little manipulation for conversion into useful power. Huge manufacturing plants must be established, desirably in remote and inaccessible places, and equipped with special machinery. A whole army of workpeople and directors must be built up. Means of safe storage and distribution to users must be provided, and devices for the efficient utilisation of the energy must be invented. It is unreasonable to imagine that such a programme can be carried out rapidly. For the time being engineers can only see the atom as a new kind of fuel. Their thoughts go no further than using it in place of coal or oil for the generation of steam destined to drive an engine or turbine. Even that restricted use bristles with problems of the first order. A new technique must be developed; means of releasing the energy slowly under rigid control must be found. That will not be easy. Problems of a new kind, many unsuspected so far, will certainly present themselves, as always in technological developments. Amongst such problems must be included the shielding of a highly radioactive material. Just as radium must be kept in thick lead safes, so must the prepared uranium be confined lest it do harm to those near it. Even the "products of combustion"—we use the convenient boiler term—may be dangerous. If they retain even a trace of radioactivity—as some physicists think probable—they may have serious and persistent ill effects on vegetable and animal life. The risk cannot be run, and long before uranium is used for the generation of power on a great scale, such difficulties and dangers as these must be overcome.

When, therefore, we look at the whole field we are able to say with no little relief that for many years to come power engineering will remain as we have always known it, and that only slowly, slowly, will nuclear energy make our coal mines, our oil wells, and our dams museum pieces and vestiges of a departed civilisation.

British Achievements

Amongst the events of the past year there are none that we look back upon with greater pleasure and satisfaction than the release of official information about the scientific and technical accomplishment of British engineers and scientists during the war. In the last quarter of the nineteenth century the confidence of English industrialists was badly shaken. The peak of their world superiority as exemplified by the Great Exhibition of '51 had been passed. They had taught other nations how to do what they themselves did, and English capital had been poured out on enterprises far over the seas. And now their pupils had become their rivals and competitors. Untrammelled by more than seventy-five years of traditional practice, unhampered by the congestion of industrial areas, and the existence of old buildings, these newcomers advanced more rapidly than their teachers. Quick to learn and blessed with internal advantages, America and Europe began not only to supply requirements which the United Kingdom had once filled, but to challenge her export trade. In these circumstances the English grew

anxious about themselves; they became introspective; they exposed their own failings and bemoaned their own weakness. The pendulum which had swung too far to the right in exultation now swung too far to the left in depression. Self-examination loses its efficacy when it leads to self-distrust. Confidence in one's own abilities is essential to success. Never more than in the five and twenty years between the wars were we so ready to underrate ourselves. Never more than during the recent wars did we surprise our enemies, our friends, and ourselves by the revelation of qualities that even we ourselves had believed we lacked.

Whilst secrecy was necessary only a few outside the closed ring knew what the achievements of British science, pure and applied, were; only a few knew how we had foreseen the devices of our foes and had prepared counterplans; only a few outside those concerned knew anything of the famous "operations" like "Mulberry"—the most marvellous "secret" of all time—"Pluto," "Fido," and the rest. Only a few knew of strange devices, and of mines and countermines, and means of detecting and destroying submarines. Only a few knew more than a very little of the marvels of Radar.

But since the utter defeat of Germany and Japan "release" has followed upon "release" and the long chain of secrets has at length been exposed. And what does it reveal? No less than that the bitter self-criticism and despondency of past years were unjustified. It may be that this time, as so often in history, it needed a great emergency to bring out the qualities of the British people; it may be that the war was a mirror to ourselves; it may be that we awoke from lethargy. But whatever the cause, the fact remains that our native science was able to meet every call that was made upon it, and that our industrialists were able to translate rapidly into workaday things the inventions and discoveries of the scientists. We need not dwell here upon the details. In other pages of this issue accounts of them will be found. It is sufficient in this place to insist that through the war British science and industry—we make them one—refound itself. With that lesson before us we can enter the future years in the sure knowledge that keeping confidence in ourselves, we are competent to do all that we may be called upon to do.

A Labour Government

Soon after the defeat of Germany the Coalition Government, which had carried the nation safely through the trials and tribulations of the long years of war, decided to "go to the country." A General Election was held in early July, with a result that surprised all political parties. Labour was returned with an overwhelming majority. In a few days Mr. Attlee had formed his Cabinet and a Socialistic Government with a dominating majority entered into power for the first time in Great Britain's history.

It had been fully recognised that for a period after the ending of the war certain measures of control of industries would be imperative, and the Coalition Government had shown an inclination to consider favourably putting public services under the general direction of the State. But the Labour Government went further. It proclaimed in the King's Speech its intention fully to nationalise the Bank of England and the mines, and hinted broadly that gas and electricity undertakings and transport would also become State properties. A Bill for the nationalisation of the Bank was rapidly brought in and rapidly passed. That was a comparatively simple operation. It seemed to make so little difference that opposition to it was never strong. Then came, just before Christmas, the Bill for the nationalisation of the coal and ancillary industries. At about the same time the Minister of Fuel and Power met representatives of the gas and electricity supply industries. These interviews are generally regarded as foreshadowing further early nationalisation.

National Collieries

Whilst the Coal Industry Nationalisation Bill is naturally largely concerned with financial questions, it outlines the form of organisation proposed for the operation of the mines in the public service. For this duty a National Coal Board, comprising nine persons appointed by the Minister of Fuel and Power, is to be set up. After acquiring the "colliery undertakings"—a comprehensive title—it will manage the industry and study its efficient development. This Board will be subject to the general direction of the Minister of Fuel and Power, who will be assisted by two Councils, one for industrial and the other for domestic consumers.

The powers to be given to the Board are comprehensive. It will engage in all the duties and functions of a colliery company, will provide facilities for research and training, and will seek the advancement of the safety of coal mining personnel and promote their health and welfare. In fact, it will do just what many colliery proprietors already do. But, unlike them, it is, apparently, to have a guaranteed revenue "not less than sufficient for meeting all outgoings properly chargeable to revenue account on an average of good and bad years."

Discussion of the Bill, which we summarised in our last issue of the year and which is touched upon in Sir Richard Redmayne's survey of the industry begun in this issue, will take place in the House of Commons at the end of this month. Whilst the House must pay much attention to the financial measures proposed for the compensation of colliery owners, there can be little doubt that the composition and power of the Board will be carefully scrutinised. The Minister of Fuel and Power has already made it plain that he alone will make appointments to the Board. Whilst he will select men of experience and capacity in industrial, commercial, or financial matters, in applied science, administration, and the organisation of workers, it seems that the colliery interests—who may be presumed to have valuable knowledge and experience— are not to be consulted.

Apart from its national importance, for the settlement of the coal problem is imperative, this Bill is of especial interest as representing, it may be supposed, the type of nationalisation that the present Government proposes to adopt. It indicates, as anticipated, that the principle of the governing Board will be followed. If such Boards are left with the liberty suggested in the Bill, if they are composed of practical men and not doctrinaires, and if the Minister concerned uses his right to exercise general control with discretion, it is probable that if public services are to be State owned, then the least objectionable form of nationalisation is that now foreshadowed.

Whilst there are strong differences of opinion about the wisdom of effecting such great domestic changes as the nationalisation of various industries at a time when the country is convalescent from the wounds of war, and whilst doubts about the efficacy of national ownership are unabated, there is a general agreement in the industries already marked down for conversion to do nothing that may hinder the schemes, but to do all in their power to make them a success in the public interest.

Labour

On the whole, Labour troubles during the year were less serious than the immediate post-war history of 1918–20 rendered probable. How much of the freedom from strife may be attributed to the coming of a Labour Government cannot be estimated. In the case of the coal mines it is reasonable to suppose that with nationalisation in prospect the workers are content to live for the present in the hope of early benefits from a sympathetic Government. Other industries, too, whilst few of them wait upon nationalisation, live in the expectation that the new Government will turn a favourable eye upon the interests of the workpeople.

By far the worst disturbances of the year occurred in the concluding months, when a prolonged strike of dockers in many ports, including London, was followed by a shorter and more localised strike in the gas industry. In both these cases the men were called out by strike committees, and both outbreaks were condemned by the executives of the trade unions concerned. Since the dockers' strike jeopardised the already limited supplies of the country's food, some of which was perishable, the Government directed troops to unload ships, and thus saved the public from grave inconvenience, and even want. In the gasworks, too, it was of such importance that some industrial and domestic supplies should be maintained at a time when other fuels were barely obtainable, that the Government sent troops to carry on certain essential operations. Fortunately, the men agreed to return to work on the assurance that their "grievances" should have prompt attention, and the fear of a gasless Christmas was removed.

The Dockers' Strike

The dockers' strike raised an issue of grave importance. The quarrel in this case was far more between the men and their unions than between the men and their employers. For some time past it has been becoming more and more evident that members are prone to take the law into their own hands, defy their executives, set up strike committees, and appoint their own leaders. Evidences of this temper have been growing more common for two or three years, but the dockers' strike, and in a less degree the gasworkers' strike, brought it home painfully to public consciousness. It is, of course, giving grave anxiety to the official leaders, who have said openly that the whole fabric of trade unionism is endangered by such revolts. But clearly if large bodies of men refuse to obey their executives, it can only

be because the executives are, in the opinion of the strikers, failing to fulfil the functions for which they were elected. The rights and wrongs of the two parties need not, in this connection, be debated. It is generally acknowledged that unless discipline within the unions can be maintained, they will be a menace rather than a help to industry. But discipline, since coercion is out of the question, cannot be ensured unless the rank and file have confidence in their leaders. The conclusion is that the unions must put their house in order, eradicating, if necessary, disruptive elements, but so modifying the constitution, methods, and policy of the executives that the wishes of the members, as a whole, are justly observed. It is of the first importance to industrial peace that collective bargaining should be continued, and that bonds made between employers and employees through their representative bodies should be faithfully honoured. That demands the acquiescence of the members in the actions of their executives, and it may therefore be said that the lesson of the late strikes, particularly that of the dockers, is that the trade unions must give the closest scrutiny to their internal affairs and organisation.

American Labour Troubles

It is impossible in this connection not to contrast labour conditions in the United States with those at home. There, as the year drew to its close, matters passed from bad to worse, and the prospect of a general strike in the steel industry, involving 200,000 men, on January 15th added to the gloom. The number of strikers, mainly in the automobile industry, amounts to tens of thousands, and the forced lock-out of many works, owing to lack of materials, has greatly increased the number of unemployed, already approaching one million. The strikes largely organised by the C.I.O. (the Congress of Industrial Organisations) are mainly for greatly increased earnings, and it is manifest that there is a total lack of sympathy between employers and employed, who are at daggers drawn. In an attempt to effect conciliation, President Truman has set up, or proposed, one or two fact-finding committees, so far unconstitutionally, but, with the approval of Congress, to be made official a few weeks hence. Oddly, as it seems to us, the workers are as much opposed to these committees as the employers. The objection of the latter to open their business affairs to prying eyes can be readily understood, but if, as the workers contend, the facts would reveal that much higher wages could be paid without crippling industry, it is not easy to understand labour's objection.

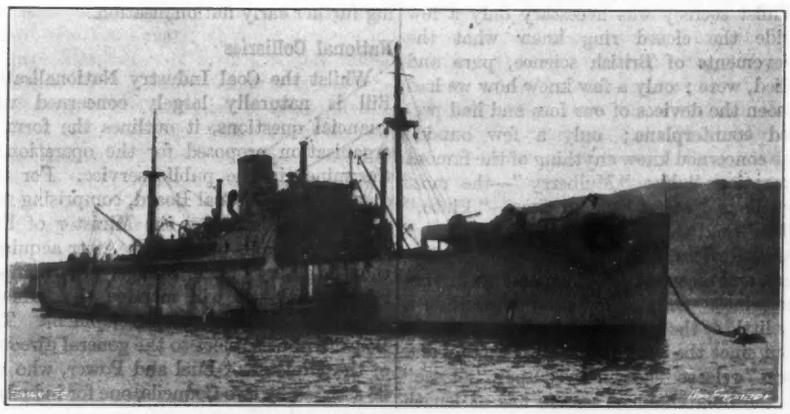
What the repercussions of these outbreaks in America may be it is impossible at present to say, because the crisis has not yet been reached. But American economists view them with grave concern, foreseeing that they may be the cause of a plague of unemployment, and that they may hold back at the very time when it is most wanted and when the United States has most to gain from it, the industrial development of the country. To us in this kingdom, too, the prospects cause anxiety, for we are looking across the Atlantic for many things needed for our rehabilitation. We, and indeed the whole of devastated Europe, must hope that means of averting a danger that would have world-wide effects will be discovered.

Technical Achievements in the Navy

(By our Naval Correspondent)

No. I

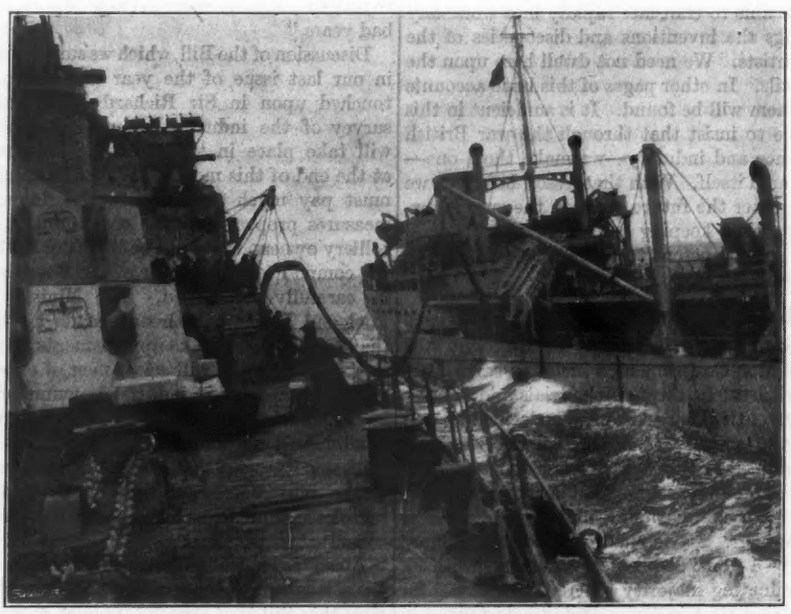
AT the end of the year of the termination of the greatest technical and maritime war in history, one cannot attempt to set out the technical achievements of that year. With the close of hostilities the veil of secrecy has been lifted from a number of matters, and these must take their place in this review, although the story of their development in most cases began long before January 1st, 1945.



H.M. ACCOMMODATION SHIP "SOUTHERN PRINCE"

The Fleet Train

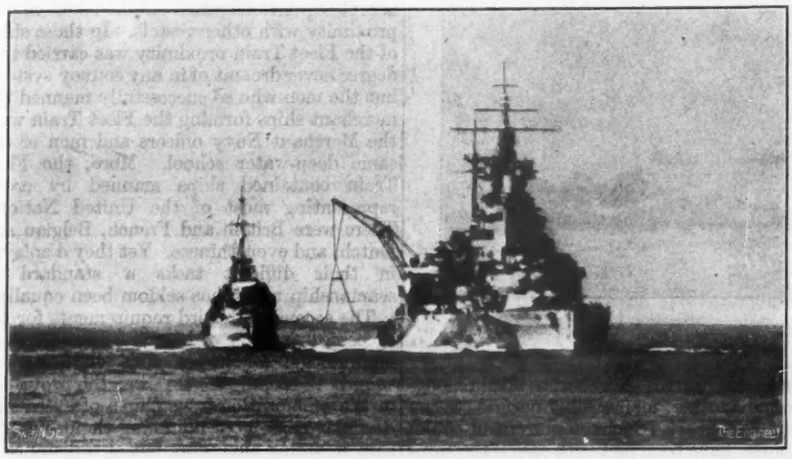
Of all the naval developments which have been thrust up in the forcing house of war, none is more important than the evolution of the Fleet Train. It was the Fleet Train which enabled the striking fleet in the Pacific to operate 3000 miles and more from its base for as much as two months at a time. This resulted in the battering of Japan without a respite, which the Japanese might have been able to use to reorganise and recover from individual blows, and thus played a decisive part in the Allied victory in the East. It is no exaggeration to say that the technique of the Fleet Train has completely revolutionised naval warfare. The strategical and even some of the tactical potentialities of warships have been enormously increased. No longer is the fighting fleet tied to the proximity of established naval bases. It has been given the ubiquity of the days of sail, allied to the infinitely greater mobility conferred by mechanical propulsion. Ever since sail gave way to steam, engineers and designers have striven to give ships a longer operational radius. Now the Fleet Train has multiplied by many times the best that had hitherto been considered possible.



CRUISER REFUELLING AT SEA

The conception of the Fleet Train is not new. Nor is it entirely a product of this war. Before the war the Naval Staff were well aware that the existing and long-established naval bases might prove inadequate, in the

geographic sense, to the strategic requirements of a future war. For this reason there was developed a special "Mobile Naval Base" organisation. Here was the first step towards the evolution of the Fleet Train. There is a belief that the entire function of the Fleet Train is to fuel, ammunition, supply, and cater for the needs of the fleet while at sea and close to the forward area of operations. This is certainly the most spectacular and most difficult of its functions, but there are



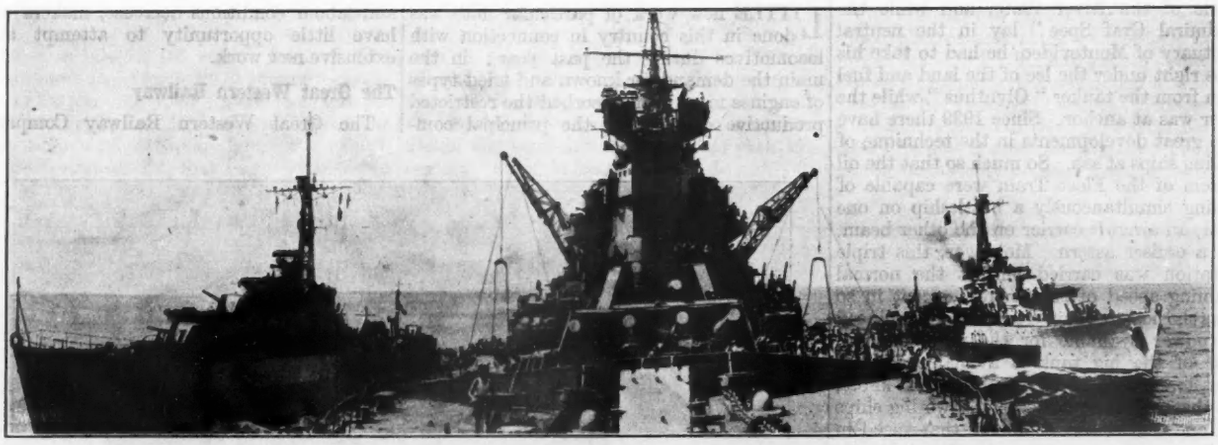
BATTLESHIP REFUELLING DESTROYER AT SEA

others. Chief among them is the ability to convert open anchorages in deserted atolls into temporary fleet bases at which the fleet can obtain every supply and service that it may need. This is, in effect, the development of the "mobile naval base" idea. There is, however, a difference, and one which has been dictated by the rapidly changing circumstances and requirements of a major naval war fought over distance and for lengths of time never before contemplated

not all in operational use when Japan surrendered, but those which were not yet ready at that time would have been in operation by now. Not a few of the components had required some two years of conversion in order to make them efficient for their new tasks.

It was so with the first two of the Fleet Repair Ships—vessels which were capable of carrying out battle repairs to battleships, aircraft carriers, and cruisers. The first two of these ships were the ex-Cunard White Star liners "Antonia" and "Ausonia." So successful were they in their new guise that the conversion of three more was ordered in 1943, but these did not come into service as Fleet Repair Ships before the Japanese surrender. These later three ships were the "Artifex," "Alaunia," and "Ranpura."

The repair machinery installed in these vessels was so extensive that it commandeered nearly all the living accommodation. The



BATTLESHIP REFUELLING DESTROYERS AT SEA

for a fighting fleet. With the Fleet Train every service and every requirement is shipborne, and therefore 100 per cent. mobile. With the Fleet Train all fuelling, ammunitioning, victualling, and storing, and all that is required for forward repairs, even up to the anticipated battle repair requirements for the heaviest ships, is seaborne.

Composition of the Fleet Train

The composition of the Fleet Train is worth some study. The details given below were

machinery, when in full operation, in fact, demanded the work of at least 700 men in each ship, but when the machinery was installed the ships could accommodate only 200 of the Special Repair Ratings (Dockyard) needed to work the machines and be available for carrying out urgent battle repairs. Thus it became necessary to provide accommodation ships to act as floating barracks attending upon the Fleet Repair Ships. The first units to go into service as accommodation ships for this duty were the ss. "Lancashire" and the ss. "Southern Prince." Others were on order to attend upon the new Fleet Repair Ships, but the orders were cancelled when the need for them lapsed with the surrender of Japan.

In addition to the Fleet Repair Ships, capable of handling battle repairs for the big ships, there were in the Fleet Train twenty-one maintenance ships. These were vessels fitted with machinery and carrying repair ratings for dealing with battle repairs for the smaller ships of the fleet. These maintenance ships were organised and fitted as specialists in the handling of repairs to the various forms of craft forming part of the fleet. Thus there were destroyer maintenance ships, minesweeper maintenance ships, light forces maintenance ships, and so on. They were converted under construction from Canadian "Fort" type merchant ship hulls, taken over while on the slips. They were ships of about 7500 tons.

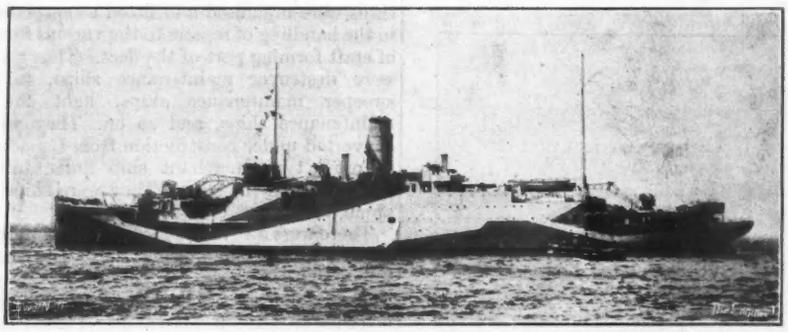
There were also in the Fleet Train a number of victualling and store ships. The most interesting of these are the issuing ships. These did not carry bulk cargoes of victualling or other stores, but were ships so fitted that they could accommodate comparatively small quantities of every sort of requirement for the fighting ships. This entailed the issuing ships being fitted with all manner of special stowages and racks for the thousands of different requirements of a warship in action. The victualling ships were organised and fitted on the basis that the ideal of the Fleet Train was the ability to carry and issue to the fighting ships 30,000 men/months of balanced diet. This, of course, means ships capable of dealing with dry provisions, wet provisions, and provisions needing refrigerated space.

In the first instance the provision of the victual issuing ships was made by taking over a number of completed merchant ships. This, however, proved unsatisfactory, for neither wholly refrigerated ships nor wholly unrefrigerated ships could fill the bill. After one or two unsuccessful experiments in trying to "make do" with what was already available, and with which the Ministry of War Transport was prepared to part, a number of 7500-ton Canadian "Fort" type merchant ships were taken over and converted to this highly specialised use.

In the "second line" of the Fleet Train there were, of course, bulk cargo carriers from which the issuing ships replenished their stocks from time to time. These were, in almost every respect, ordinary merchant

ships brought into use with the Fleet Train.

One of the most astonishing achievements of the ships of the Fleet Train was that of the issue ships, which proved themselves capable of transferring large quantities of stores to the fighting ships at sea without any special or additional fittings. The other ships which had to transfer large quantities of material and heavy weights at sea were the ammunition issue ships, and, of course, the oil tankers. The latter often carried a considerable quantity of stores and spare parts in addition to their oil fuel cargoes.



H.M. BASE REPAIR SHIP "ARTIFEX"

The lot of the oil tankers in the Fleet Train was made the harder because they had to carry high octane fuel for the aircraft of the Fleet Air Arm as well as the ordinary oil fuel for the ships. This added considerably to the risk to which they were exposed and to the complexity of their organisation.

Oil and Ammunition

At the beginning of the war the fuelling of warships at sea was a science in its infancy. Battleships and aircraft carriers had fuelled destroyers at sea, but this had been a tedious and somewhat dangerous business. It will be remembered that when Commodore Harwood had to fuel his cruisers after the Battle of the River Plate, and while the "Admiral Graf Spee" lay in the neutral sanctuary of Montevideo, he had to take his ships right under the lee of the land and fuel them from the tanker "Olynthus" while the latter was at anchor. Since 1939 there have been great developments in the technique of fuelling ships at sea. So much so that the oil tankers of the Fleet Train were capable of fuelling simultaneously a battleship on one beam, an aircraft carrier on the other beam, and a cruiser astern. Moreover, this triple operation was carried out at the normal steaming speed of the tanker, except in so far as the power required for pumping reduced the power available for the main engines. Most of the big tankers available for the Fleet Train had a speed of only 10 to 12 knots, but these could fuel the fleet—two big ships and one cruiser at a time—at that speed in the long swell prevalent on the North Pacific and in a sea of force 6. In some cases the Americans fuelled their ships at sea at an even higher speed, but that was due solely to the fact that they had at their disposal tankers capable of maintaining a higher speed.

At first sight the transfer of heavy weights such as ammunition at sea in anything but a flat calm would appear to pose insuperable difficulties. When one comes to think of the fact that the ships of the fleet had to be supplied with ammunition up to 14in. calibre and heavy bombs, while under way in a part of the world where calm weather could not be expected, one can appreciate one of the reasons why the enemy never thought that we were capable of carrying out such a task.

In fact, however, large quantities of ammunition have been supplied, even to the 14in. gun battleships, while at sea in the North Pacific and while all ships were under way and maintaining a speed of at least 10 knots. Three factors have contributed in making possible this amazing evolution. The first and overriding requirement was good seamanship, for the ships had to steam alongside one another, maintaining perfect station about 80ft. apart. Such a requirement could, of course, have been met with ease if the ships had been of homogeneous performance, if they had been fitted with identical forms of steering gear operated by instantaneous telemotor or electric action, and if they had been manned by men specially trained in this ultra-close station keeping. None of these things, however, obtained. The ammunition issue ships were, in essence, ordinary merchant ships, and as such having very different reactions to wind and sea to the battleships, aircraft carriers, and cruisers which they supplied. They were not fitted with special steering gear or double rudders; in fact, they had only the steering gear built into them when they had been designed to steam on straight courses for long periods, and to give everything else that floated as wide a berth as possible. There was also the personnel factor. It was widely stated in and after the last war that the reason for delay in introducing the convoy system was the reluctance of the merchant ship officers to accept regulations which entailed steaming in proximity with other vessels. In these ships of the Fleet Train proximity was carried to a degree never dreamt of in any convoy system, but the men who so successfully manned the merchant ships forming the Fleet Train were the Merchant Navy officers and men of the same deep-water school. More, the Fleet Train contained ships manned by crews representing most of the United Nations. There were British and French, Belgian and Dutch, and even Chinese. Yet they displayed in their difficult tasks a standard of seamanship which has seldom been equalled.

The second and third requirements for the successful transfer of heavy weights, such as ammunition for heavy guns, in a seaway were both technical. One was the provision, in the ammunition issue ships, of extra-long derricks, capable of plumbing the decks of a ship steaming alongside, but at a distance of some 80ft. The other was the provision of automatic self-rendering winches to serve these derricks. It was chiefly the latter, coupled with the magnificent seamanship displayed, which was responsible for the fact that in this very difficult operation, oft repeated, there was not one single accident, and not one man was hurt.

(To be continued)

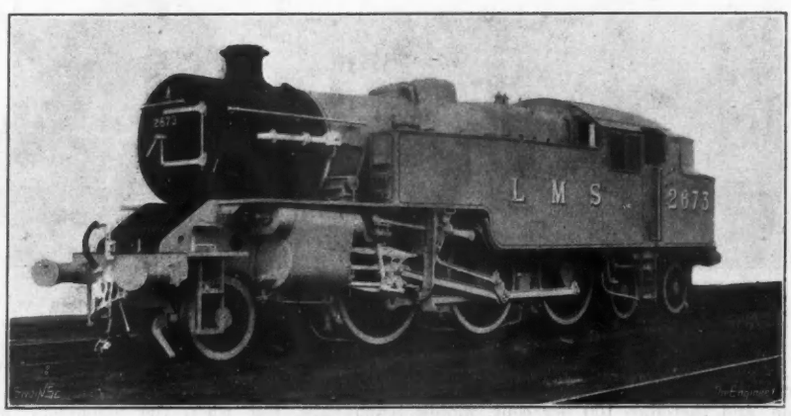
Railway Locomotives of 1945

No. I

LITTLE new work of particular note was done in this country in connection with locomotives during the past year; in the main the demand for known and tried types of engines more than absorbed the restricted productive capacity of the principal companies. Most of the new engines are based upon existing types, but include a number of modifications and certain improvements, which, although interesting, are not of an outstanding nature. It would seem that until the present restrictions imposed by material and labour conditions decrease, makers will have little opportunity to attempt any extensive new work.

The Great Western Railway

The Great Western Railway Company placed in service the first of a new series of 4–6–0 engines, designated as the "1000" class. As may be seen from the view on page 17, this engine closely resembles the "Hall" class, upon which its design is largely based. It actually incorporates a large number of

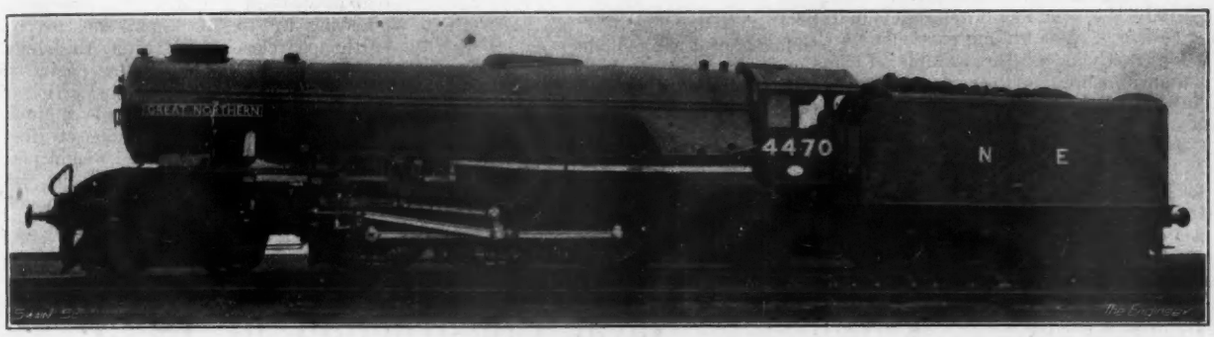


L.M.S. IMPROVED TANK ENGINE

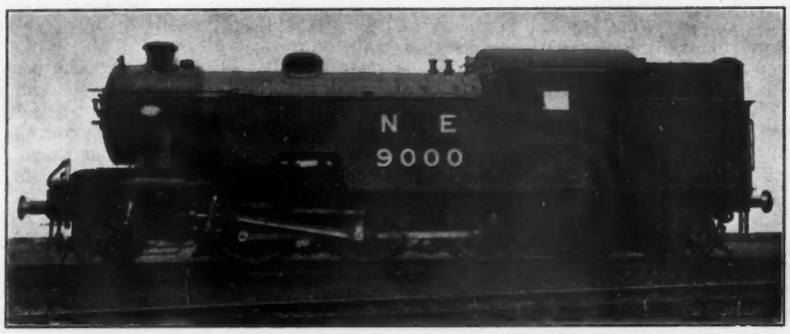
modifications, introduced by Mr. F. W. Hawksworth. In addition to these changes, the new engine has a boiler working at a pressure of 280 lb. per square inch and a new design of superheater giving a higher degree of superheat than any other of the company's locomotives. The barrel is just over 12ft. 7in. long, with outside diameters between 5ft. 8¾in. and 5ft. The Belpaire type fire-box is 9ft. 9in. by 5ft. 10⅞in. outside at the top and 9ft. 3in. by 4ft. at the bottom, with heights of 6ft. 8 $\frac{11}{16}$in. and 5ft. 1 $\frac{23}{32}$in., giving a heating surface of 169 square feet. Of the total heating surface of 1979 square feet, the fire tubes provide 1545 square feet and the superheater tubes 265 square feet. The grate area is 28·84 square feet. For experimental purposes the first engine was fitted with a double blast pipe and chimney, with which, we understand, trials are still proceeding.

A separate saddle of welded construction is set between the main frames, which are of steel plate and extended forward beyond the cylinders. The two 18½in. by 30in. cylinders are cast separately and have 10in. diameter piston valves. A plate frame type bogie has a fabricated centre and is independently sprung. Alone, the engine has a length of just over 38ft., which is increased to 63ft. with the tender. Its total weight of 76 tons 17 cwt. has the following distribution: bogie, 17 tons 15 cwt.; each coupled axle, 19 tons 14 cwt. A new tender of simplified design has been developed for use with this engine. Fully laden it weighs 49 tons, its welded tanks carrying some 4000 gallons of water and the coal capacity being 7 tons. At 85 per cent. boiler pressure the engine has a tractive effort of 32,580 lb.

A large-scale experiment is being made by the G.W.R. in the conversion of ten engines of the 2–8–4 tender "2800" class and eight tank engines of the "4200" class to burn heavy fuel oil instead of coal. The oil-burning equipment was fully described in our issue of November 16th, and consists of a weir type burner, an oil regulating cock and heater, together with a steam manifold carrying the necessary control valves. Into the coal space of the tender is fitted an oil tank of 1800 gallons capacity, which has a series of steam heating coils. On the locomotive the oil burner is mounted in a small chamber in front of the fire-box at foundation ring level. From the weir type burner oil flows over on to a ribbon of steam, by which it is caught up, atomised, and projected towards the rear of the fire-box. During the initial running period many modifications to the new equipment will doubtless be made. Although oil-burning locomotives are by no means new, the outcome of this experiment will be awaited with interest in this country.



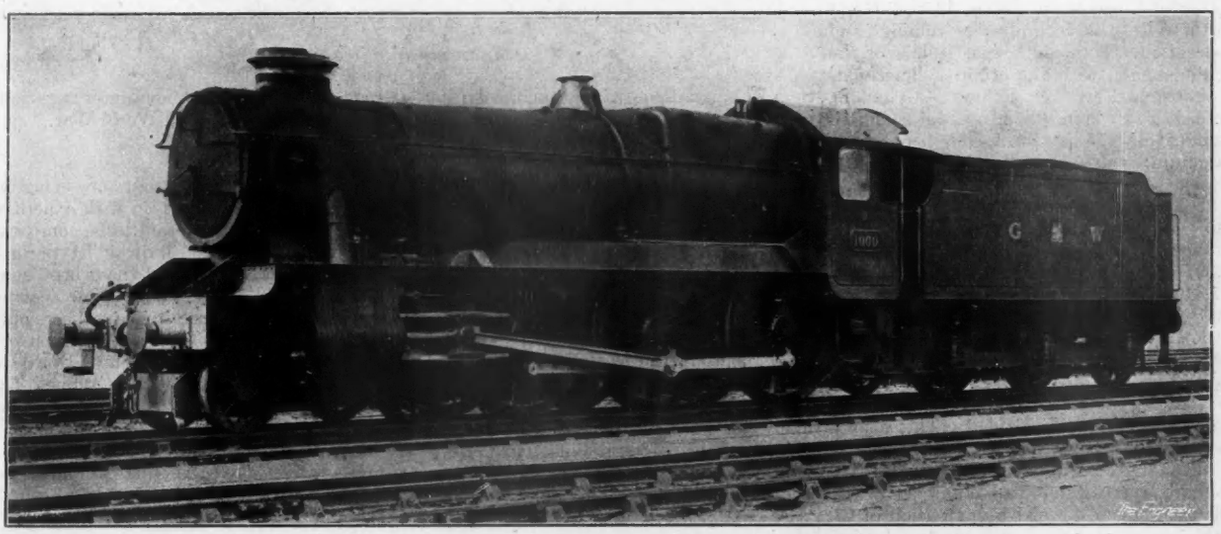
L.N.E.R. REBUILT "PACIFIC" LOCOMOTIVE



L.N.E.R. NEW TANK ENGINE

Southern Railway

For working the routes west of Exeter, on which bridges and track restrictions are in effect, Mr. O. V. Bulleid, of the Southern Railway Company, has developed a modified form of his heavy "Pacific" locomotives. A little smaller than the "Merchant Navy" class, the new engines closely resemble their prototype, as may be seen from the illustra-



G.W.R. "1000" CLASS LOCOMOTIVE

tion in our Supplement. Seventy of these engines are being built, and they will be known as the "West Country" class. For them a new nomenclature has been adopted—"21C100"—a distinct departure from usual means of locomotive classification. In it, the "2" stands for the first pair of axles, the "1" for the trailing axle, "C" three driving axles, and "100" is the number of the engine in its class. Some of their leading particulars are as follows:—Cylinders (three simple), 16½in. by 24in.; pressure, 280 lb. per square inch; driving wheel diameter, 6ft. 2in.; heating surface: evaporative, 2122 square feet; and superheating, 545 square feet; grate area, 38·25 square feet; weight on drivers, 18 tons 15 cwt.; on bogie, 15 tons 10 cwt.; on trailer, 14 tons 6 cwt.; tractive effort at 85 per cent. pressure, 31,000 lb. Following Mr. Bulleid's interesting paper, before the Institution of Mechanical Engineers, on the construction of the "Merchant Navy" engines, which was reprinted in our issues of December 21st and 28th, we look forward to an equally absorbing description of the design and building of the "West Country" locomotives.

London and North-Eastern Railway

The first engine of the London and North-Eastern Railway Company's five-year locomotive building plan is the 2–6–4 tank engine "No. 9000," which is illustrated on page 17. It has been designed to meet the operating department's need for an engine with a considerably larger water capacity than the existing 2–6–2 locomotives, and yet be within restricted axle loading. These engines, of which there are to be 110, have been built to the plans of Mr. Edward Thompson and are the first 2–6–4s made by the company. Their coupled wheels are 5ft. 2in. diameter and, although smaller than is usual for engines on passenger work, are ample for the maximum speeds likely to be required. At the same time, this size ensures the rapid starting and acceleration essential to suburban working, and also adapts the locomotive for heavy mineral haulage. Designed for a working pressure of 225 lb. per square inch, it is claimed that the tractive effort of 32,000 lb., of which the engines are capable, is the highest for their type in this country. Its tanks and bunker are of welded construction and hold 2650 gallons of water and 4½ tons of coal. In order to meet the requirements of the company's eastern section, full Westinghouse braking and a vacuum ejector have been fitted.

During the year the oldest "Pacific" locomotive of the company—No. 1470, "Great Northern"—was completely rebuilt and modernised. The leading particulars of the rebuilt engine, with the original dimensions in brackets, are as follows:—Cylinders, three, 19in. by 26in. (20in. by 26in.); maximum cut-off, 75 per cent. (65 per cent.); maximum valve travel, 6 11/16in. (5¾in.); coupled wheel diameter, 6ft. 8in. (6ft. 8in.); total heating surface, 3325·2 square feet (3455 square feet); boiler pressure, 250 lb. per square inch (180 lb.); tractive effort, 37,397 lb. (29,835 lb.); adhesive weight, 147,840 lb. (134,400 lb.); adhesive factor, 3·95 (4·5). The original engine was fitted with Walschaerts outside and Gresley inside valve gear, and in the rebuilt locomotive, in place of the conjugated 2–1 levers actuating the crank valve, an independent set of Walschaerts gear is provided. This gear is operated by an excentric having a throw of 4½in., mounted on the crank axle. The standard type of built-up crank axle with balance weights, formed by extension of the crank webs, is now fitted on the leading coupled wheels, and is driven by the inside cylinder. Exhaust from the outside cylinders passes along the outside of the frames and enters the inside cylinder casing, where it joins the inside exhaust at the blast pipe base and passes on into a double chimney. A picture of the rebuilt engine, which has been renumbered 4470, appears on page 17.

During the year the L.N.E.R. rebuilt a number of three-cylinder engines with two cylinders, in which the Gresley valve gear is eliminated. At the same time, opportunity was taken to fit the rebuilt engines with new boilers having an increased working pressure. This increase in pressure coupled with larger cylinders, has made it possible to retain practically the same tractive effort on the converted engines.

London Midland and Scottish Railway

Forty-five 2–6–4 tank engines of improved design are under construction at the Derby works of the London Midland and Scottish Railway Company, and one of them is shown in the illustration on page 16. These engines are used for all sorts of freight and suburban work and, if needed, are capable of working up to 70 m.p.h. with expresses. Although closely following the lines of existing locomotives, the new engines have a shorter wheel base of 15ft. 4in., which allows them freely to negotiate curves down to 5 chains. In order to compensate for this shortening and the increased weight per foot run, a number of economies in weight, totalling 3 tons 8 cwt., have been made.

(To be continued)

Naval Construction in 1945

By FRANCIS McMURTRIE, A.I.N.A.

No. I

British Navy

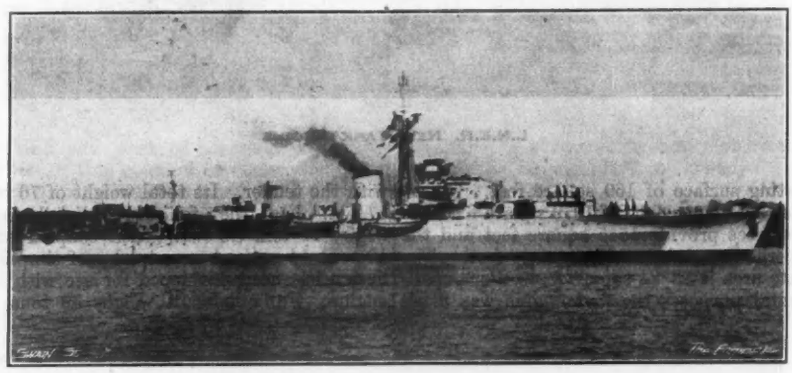
THOUGH censorship came to an end some months ago, particulars of the majority of ships built for the Royal Navy during the war have still to be released in full. Nor is it always possible to obtain official confirmation of such details on the subject as may appear in the Press. It is well to make this observation, since otherwise some of the information in this article might be deemed unduly scanty.

Battleships

Little more is known about the latest British battleship, H.M.S. "Vanguard," than was available a year ago. An aerial photograph has been published, showing her fitting out in the yard of John Brown and Co., Ltd., at Clydebank; this suggests that she has two funnels and four main turrets. From the fact that she has been officially referred to as the largest warship ever built in these islands, it may be assumed that the reputed standard displacement of 45,000 tons is accurate; the most probable armament is eight 15in. guns. There is known to be a considerable reserve of guns of this calibre, consequent on the loss of H.M.S. "Hood," "Barham," and "Royal Oak," whose spares thus become available for disposal. This is likely to have dictated the choice of the 15in. calibre in preference to 14in., as mounted in the "King George V" type, or 16in., as in the "Nelson" and "Rodney."

A similar reason—the absence of a stock of 16in. guns—may have been partly responsible for the suspension of work on the four battleships authorised under the 1938 and 1939 Estimates, the "Lion," "Temeraire," "Conqueror," and "Thunderer." There has been no word of their construction having been resumed, and it may well be that after six years of war the original design has been discarded in favour of new plans based upon operational experience.

As in 1919, there are many who contend that battleships are no longer needed, and who therefore oppose their construction. It is not proposed to enter into this controversy here, but it may be pointed out that in the United States Navy official views do not seem to support the above interpretation of the events of the Second World War.



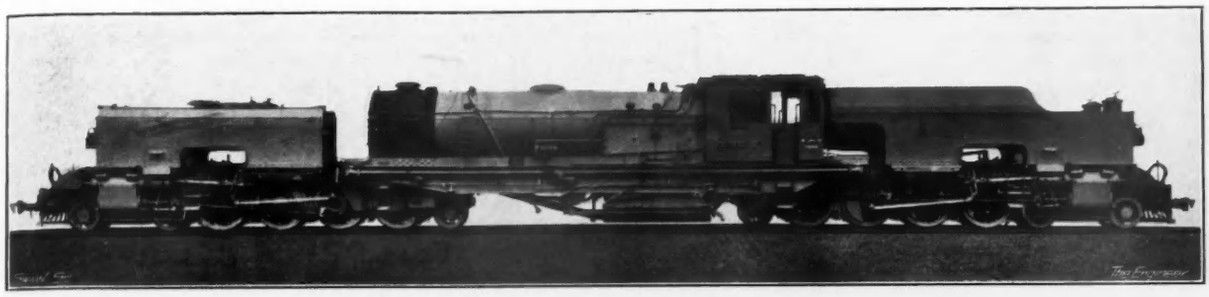
H.M. DESTROYER "ARMADA"

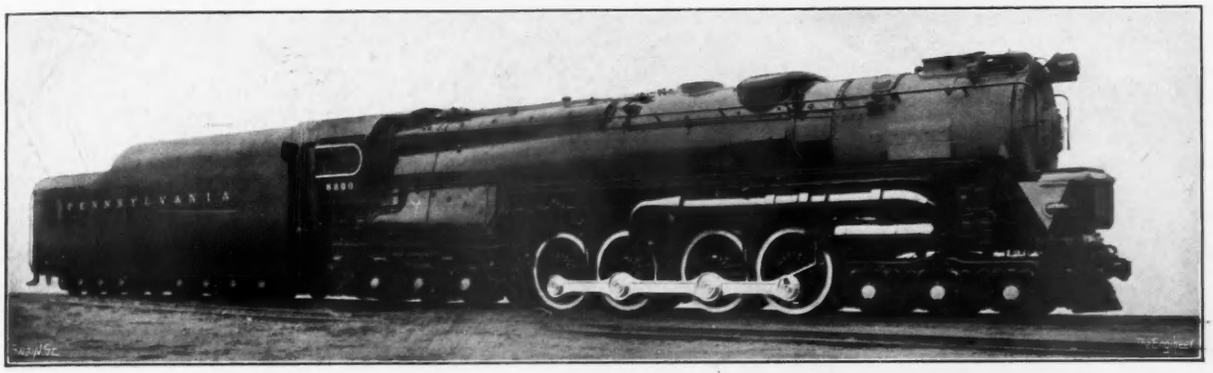
Aircraft Carriers

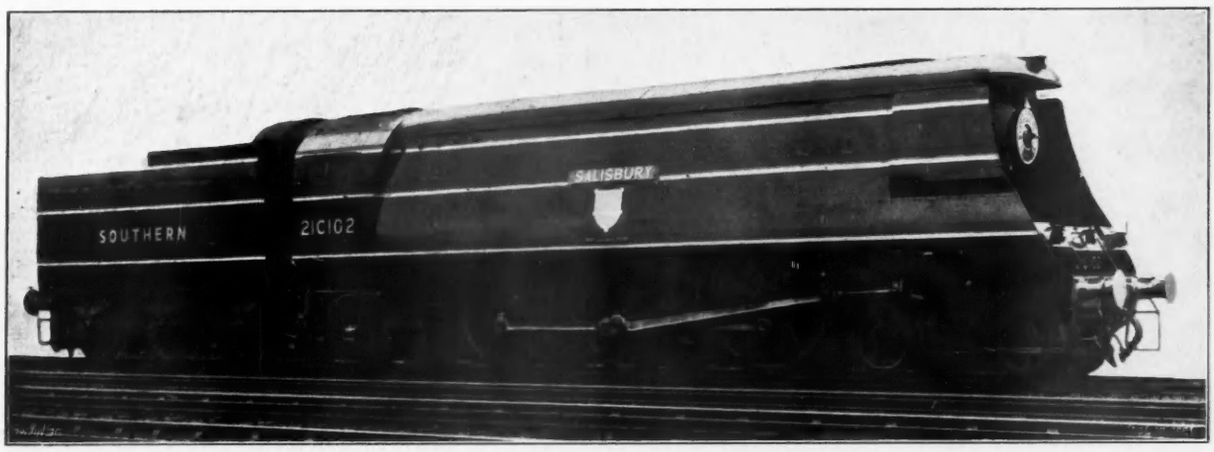
How many aircraft carriers are being built it is impossible to ascertain with exactitude. Three very large ones, said to be comparable with the 45,000-ton "Midway" type in the United States Navy, were to have been named "Gibraltar," "Malta," and "New Zealand." Orders are understood to have been placed for these ships with Vickers-Armstrongs, Ltd., Walker-on-Tyne; John Brown and Co., Ltd., Clydebank; and Cammell Laird and Co., Ltd., Birkenhead, respectively. Whether they will all be completed is questionable. A fourth ship which may belong to this class was to have been named "Africa," but it is doubtful whether she has gone beyond the projected stage.

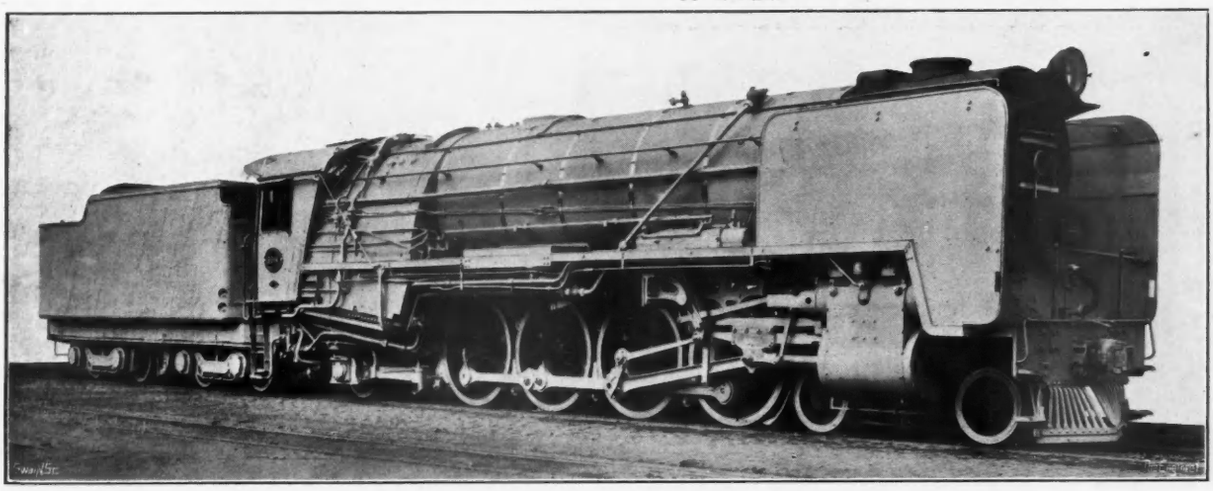
Contracts are believed to have been placed two or three years ago for H.M.S. "Ark

LOCOMOTIVES OF 1945



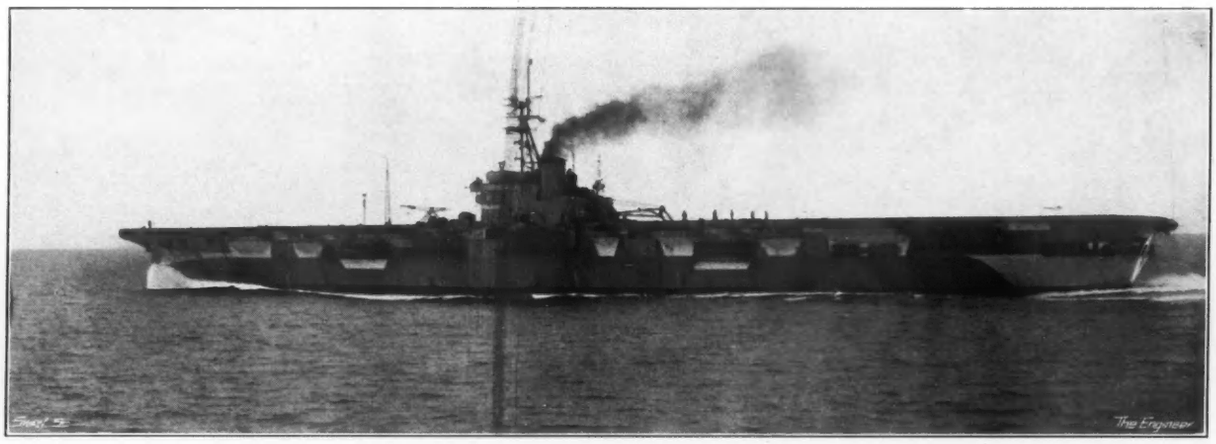


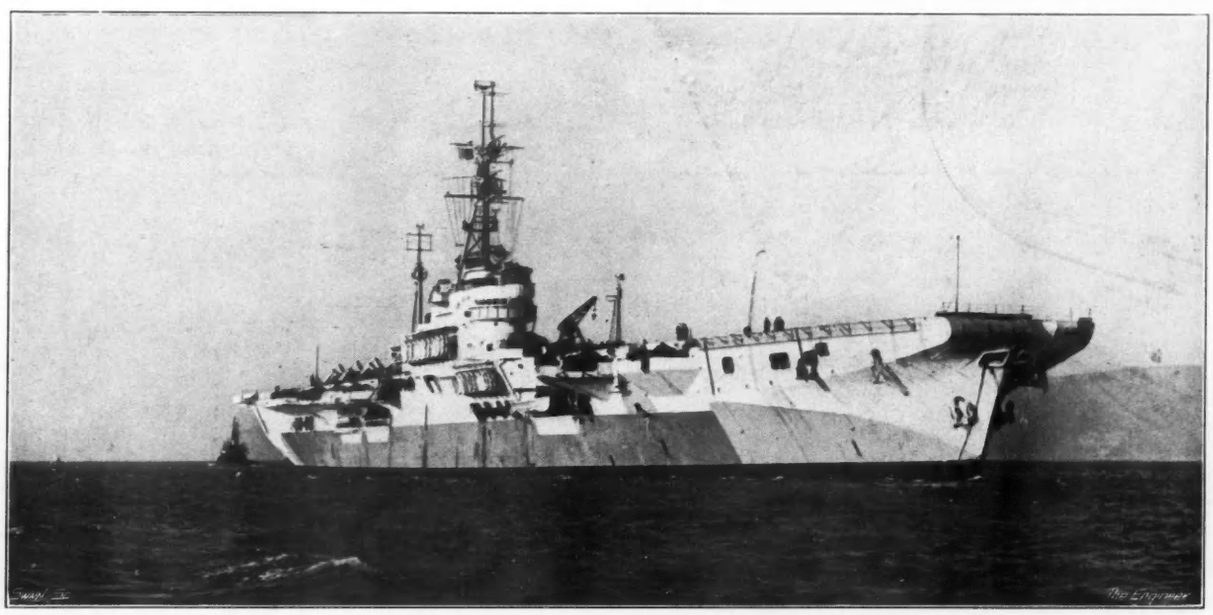




METRE-GAUGE LOCOMOTIVE FOR FAR EAST
PENNSYLVANIA RAILROAD CLASS "S-2" GEARED TURBINE LOCOMOTIVE
SOUTHERN RAILWAY "WEST COUNTRY" PACIFIC LOCOMOTIVE
SOUTH AFRICAN RAILWAYS CLASS "15 F" LOCOMOTIVE

BRITISH WARSHIPS OF 1945



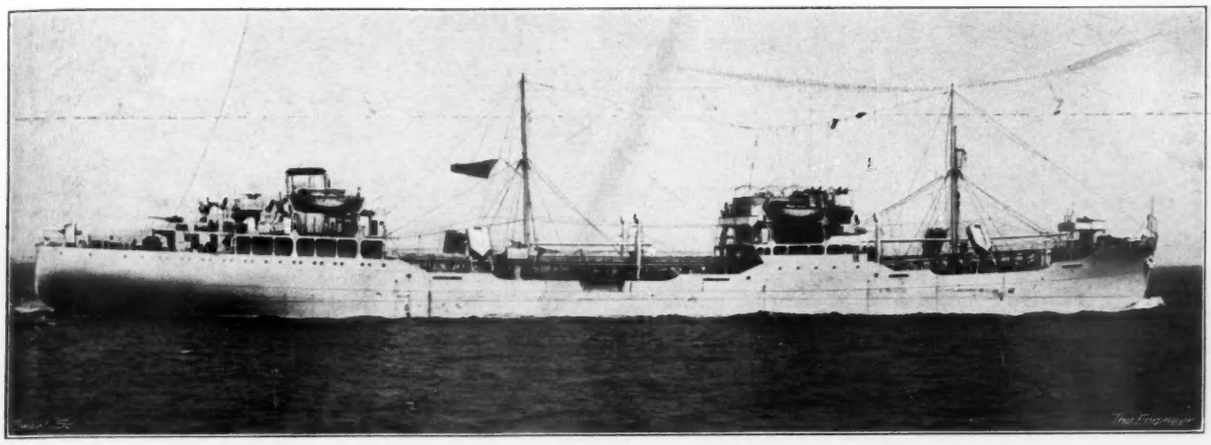


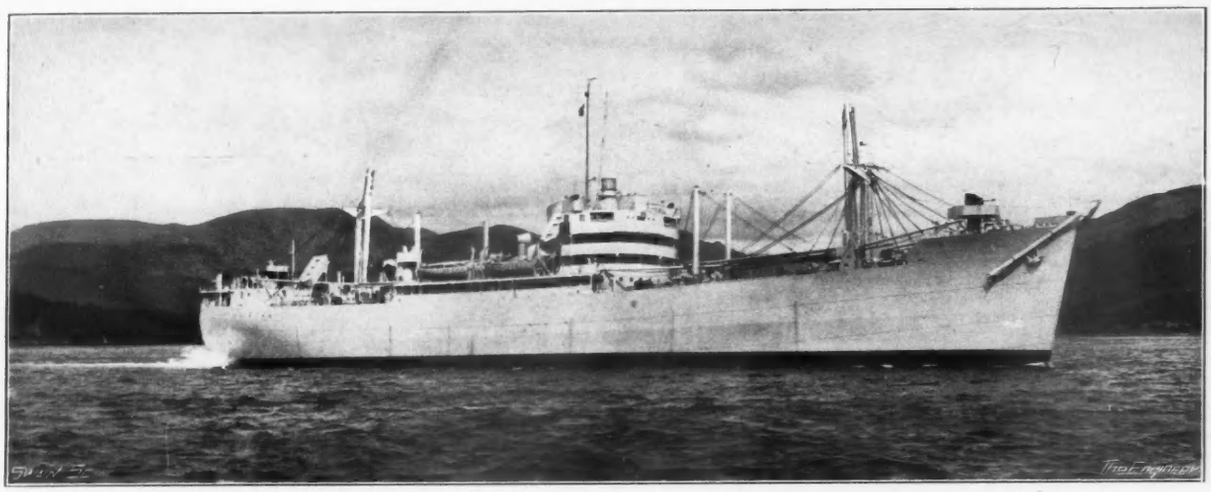
H.M. LIGHT FLEET AIRCRAFT CARRIER "VENERABLE"

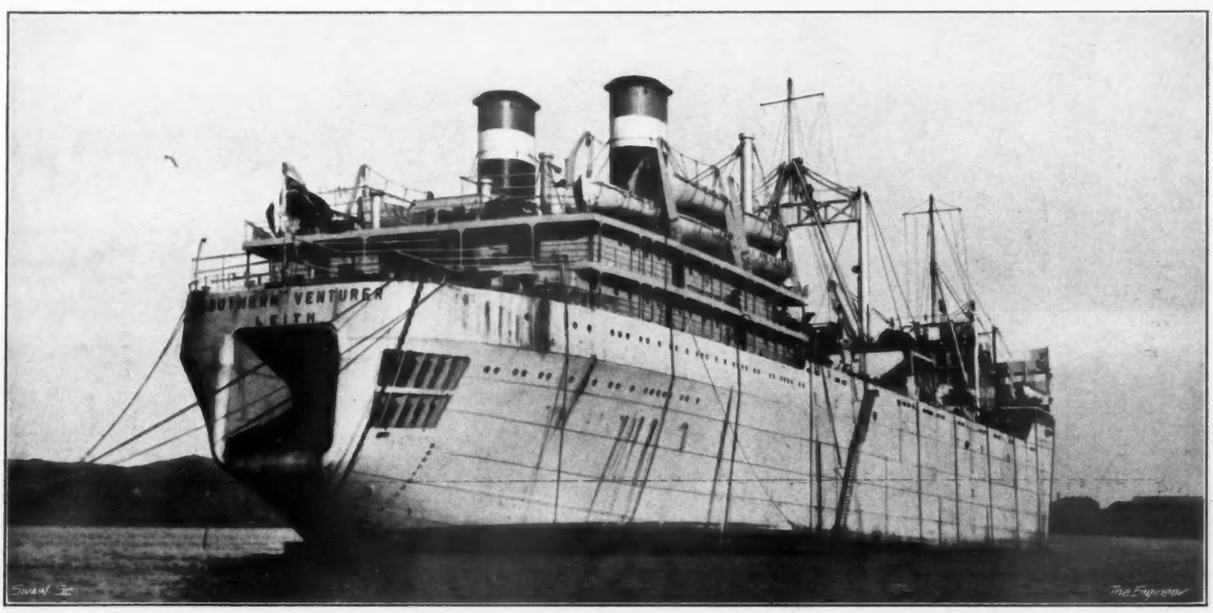
H.M. FRIGATE "ST. BRIDE'S BAY"

H.M. LIGHT FLEET AIRCRAFT CARRIER "GLORY"

BRITISH MERCHANT SHIPS OF 1945

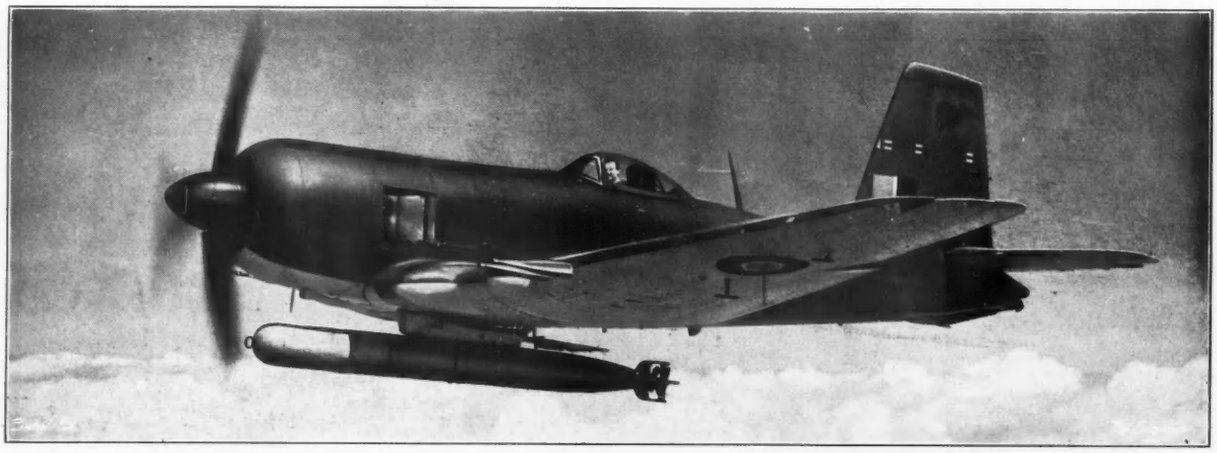


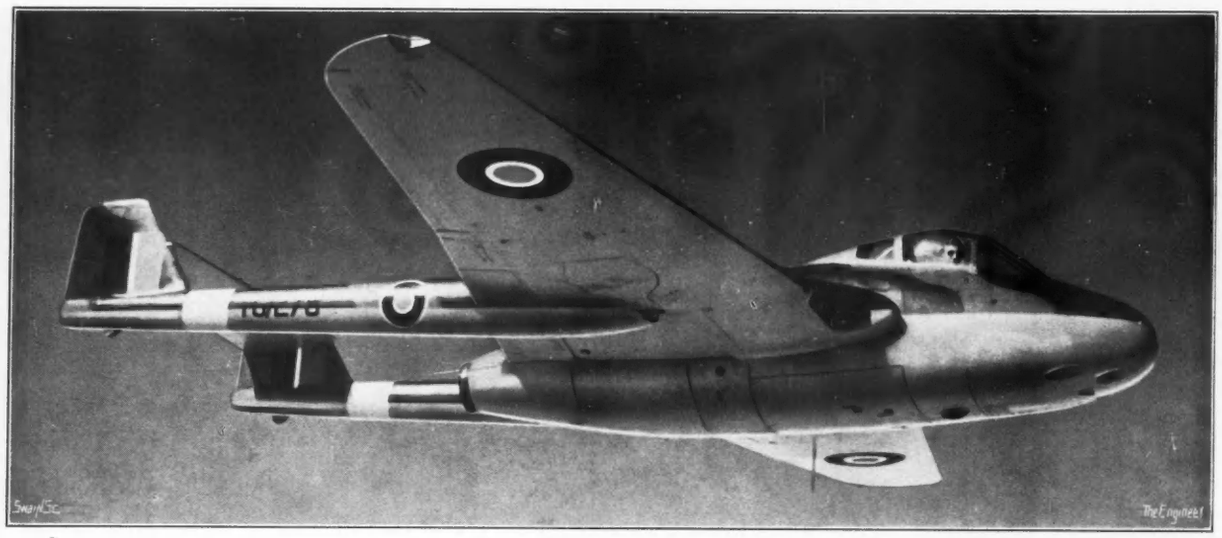




OIL TANKER "REGENT HAWK"
CARGO LINER "PARIMA"
WHALING FACTORY SHIP "SOUTHERN VENTURER"

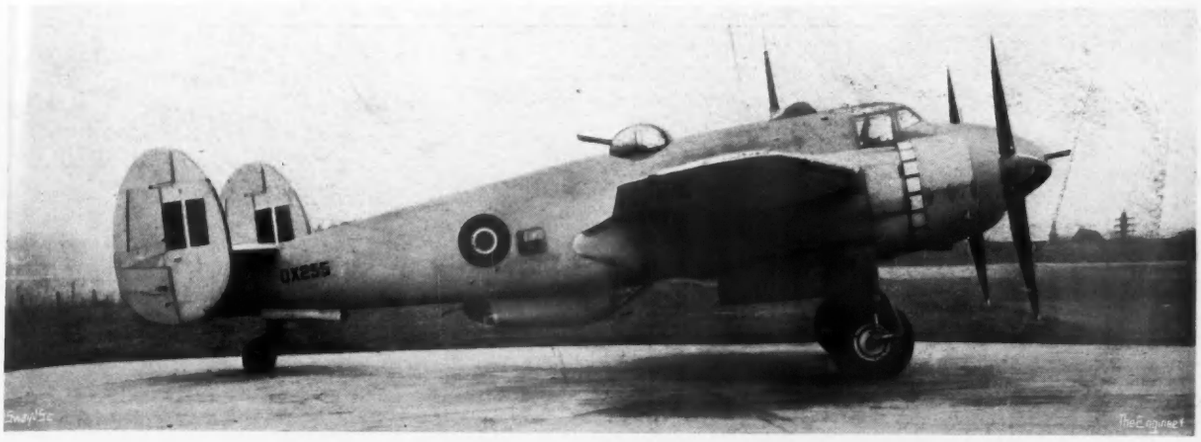
MILITARY AIRCRAFT OF 1945

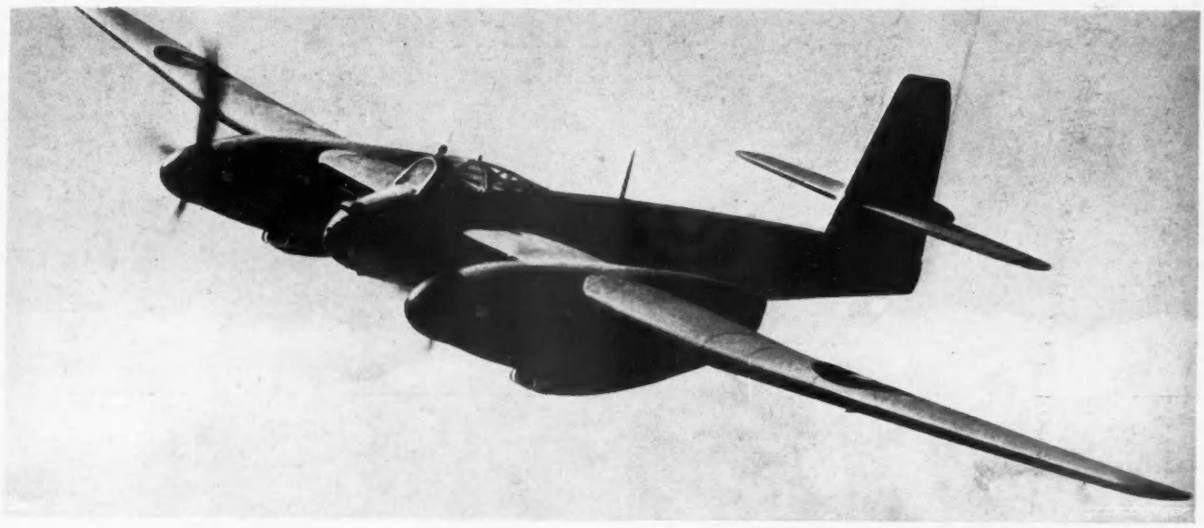




BLACKBURN "FIREBRAND" NAVAL AIRCRAFT
DE HAVILLAND "VAMPIRE" JET-PROPELLED FIGHTER
FAIREY "FIREFLY" MK. IV NAVAL FIGHTER

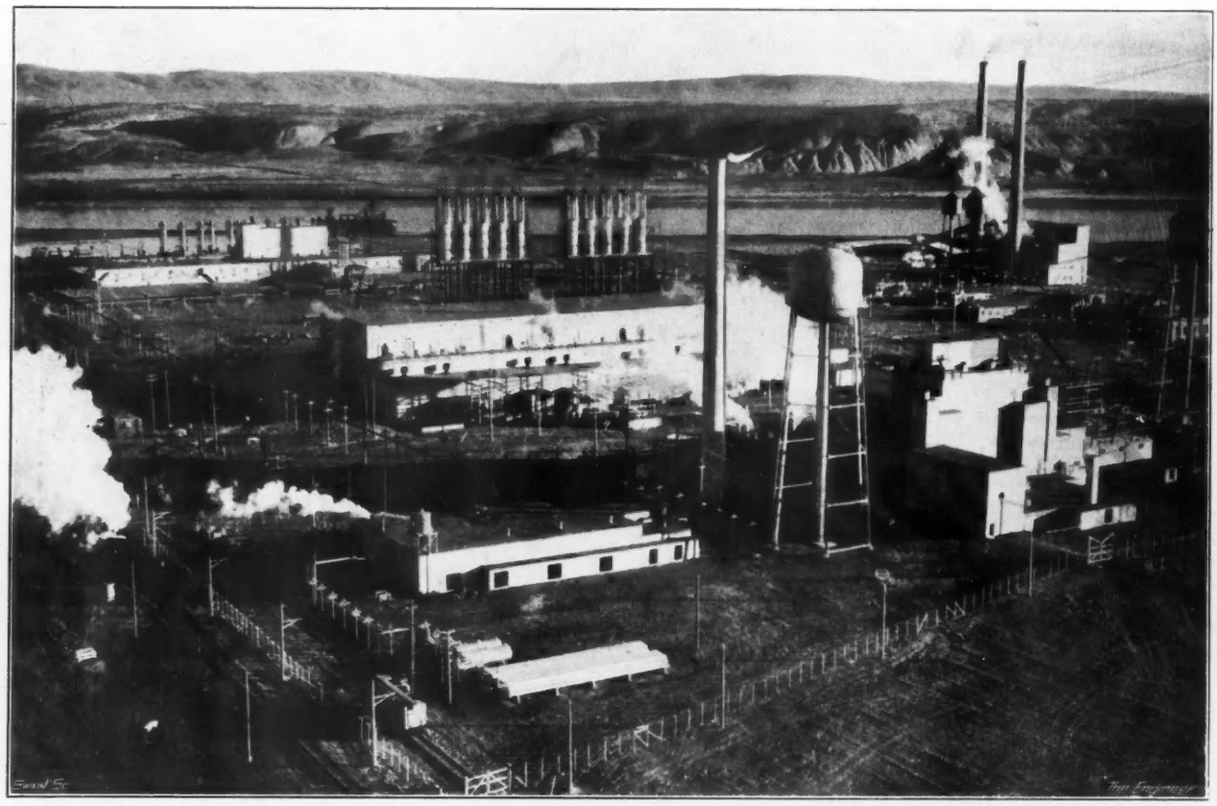
MILITARY AIRCRAFT OF 1945

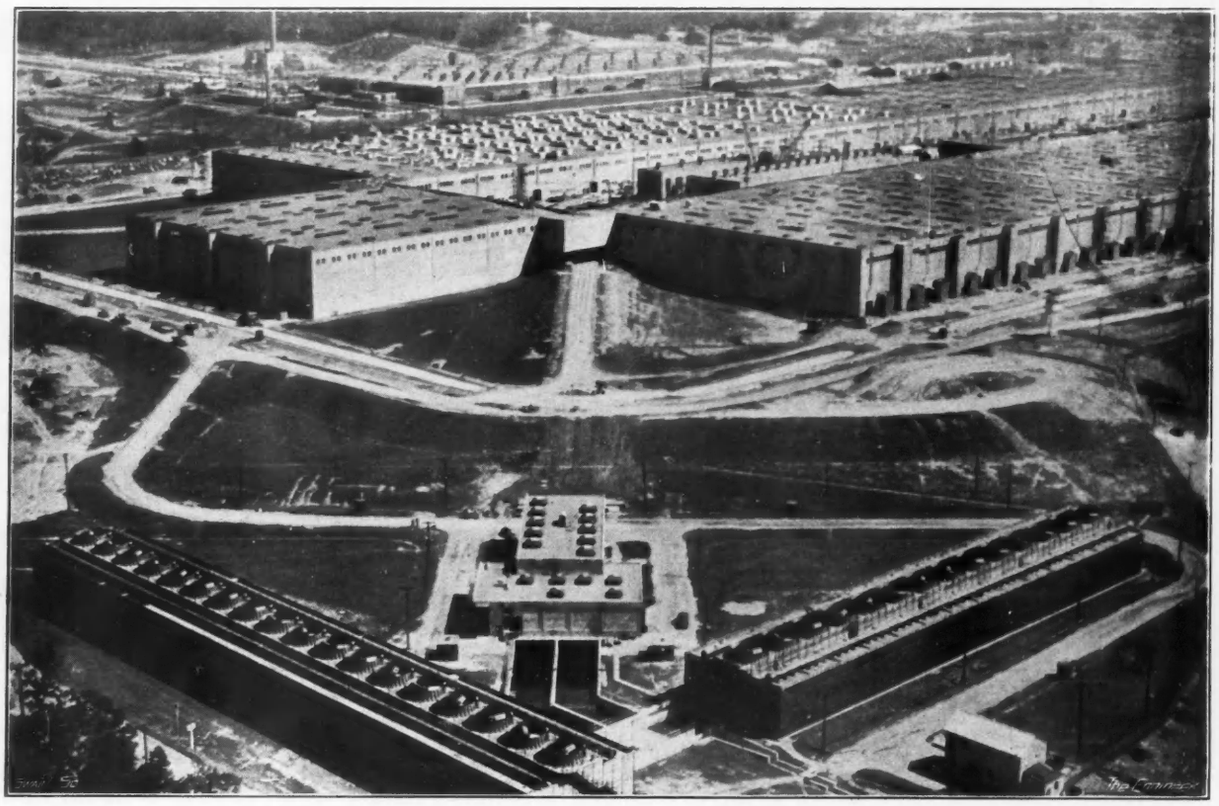




BRISTOL "BUCKINGHAM" FAST DAY BOMBER
WESTLAND "WELKIN" STRATOSPHERE FIGHTER
DE HAVILLAND "HORNET" LONG-RANGE FIGHTER

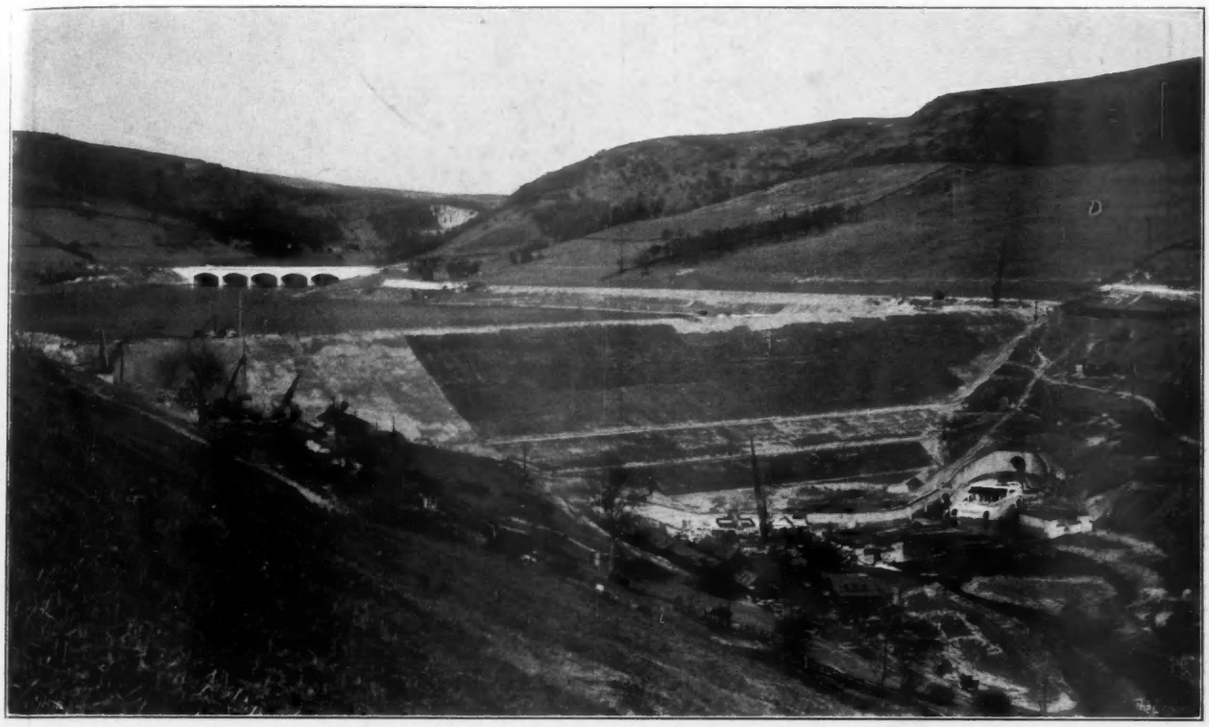
ATOMIC BOMB FACTORIES IN THE UNITED STATES

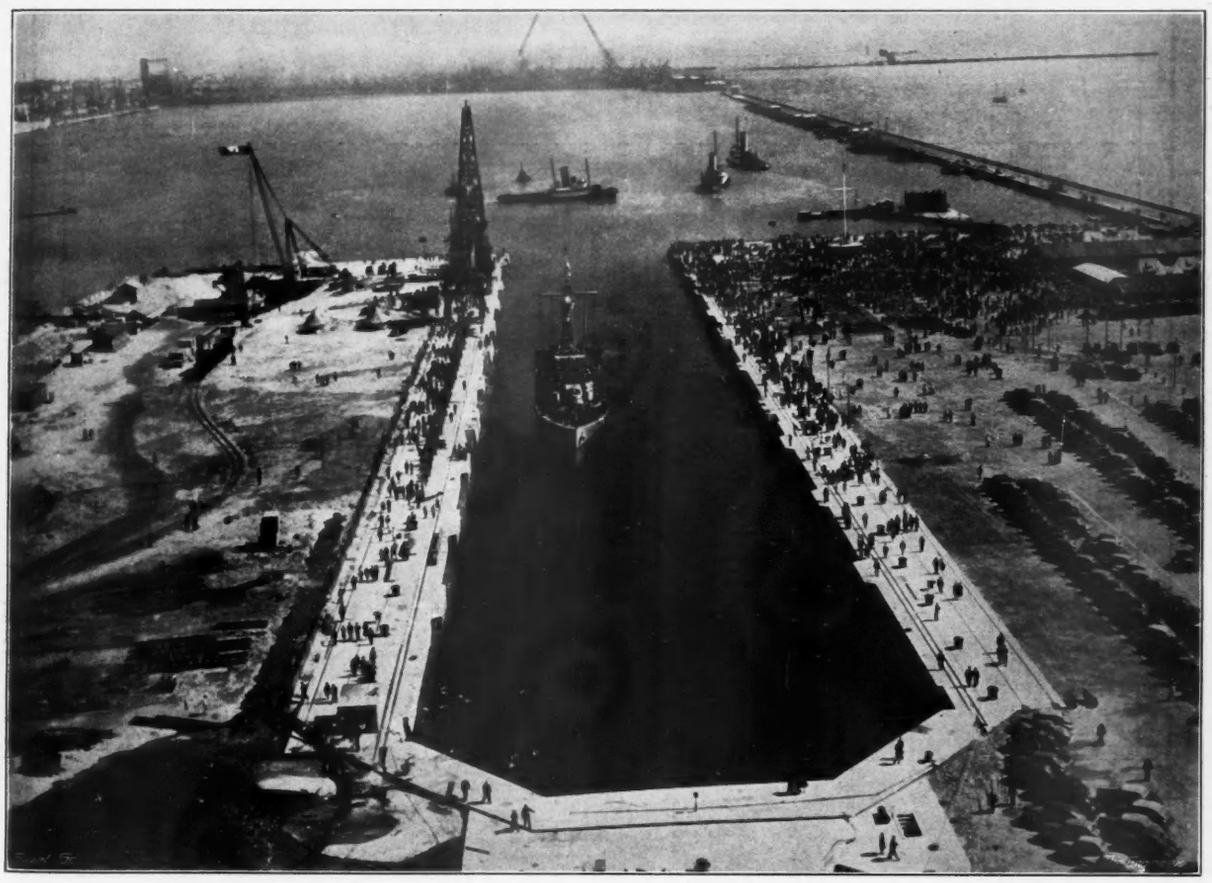




THE HANFORD WORKS, STATE OF WASHINGTON
THE CLINTON WORKS AT OAK RIDGE, TENNESSEE

CIVIL ENGINEERING WORKS OF 1945

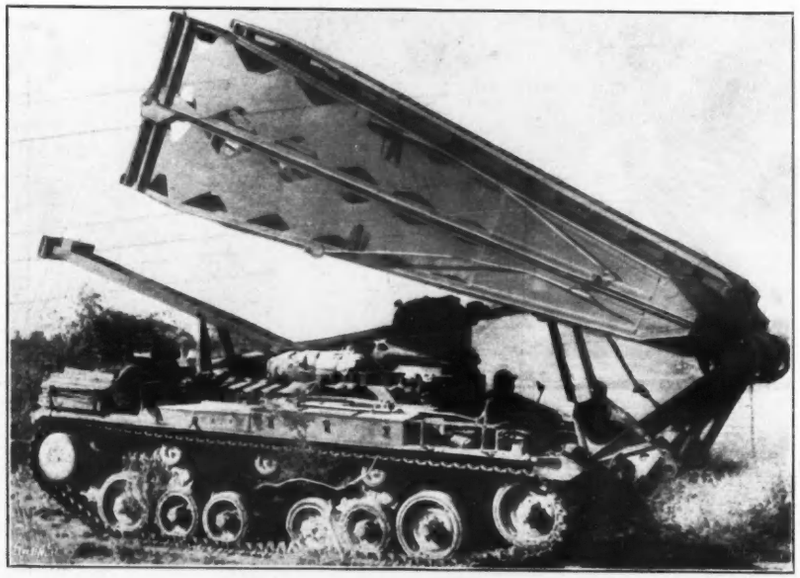




LADYBOWER DAM ON RIVER DERWENT

CAPE TOWN DOCK, SOUTH AFRICA

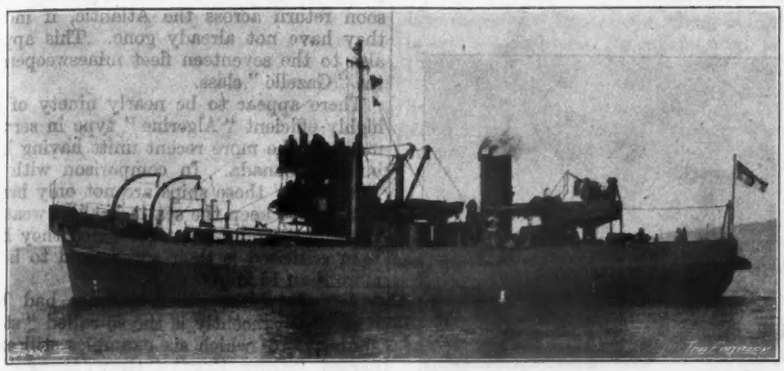
ARMOURED FIGHTING VEHICLES OF 1945



"COMET" CRUISER TANK
"HEAVY CHURCHILL" INFANTRY TANK

"CHALLENGER" CRUISER TANK
"VALENTINE" SCISSORS BRIDGE

Royal," "Audacious," and "Eagle," under construction at the yards of Cammell Laird and Co., Ltd., Harland and Wolff, Ltd., and Vickers-Armstrongs, Ltd. (Tyne), respectively. Known as the "Eagle" class, these ships are understood to displace about 33,000 tons. They are to be propelled by four-shaft turbines of the Parsons type with single-reduction gearing, steam being supplied from boilers of the Admiralty three-drum design. None of these ships has yet been launched.



COASTAL MINELAYER

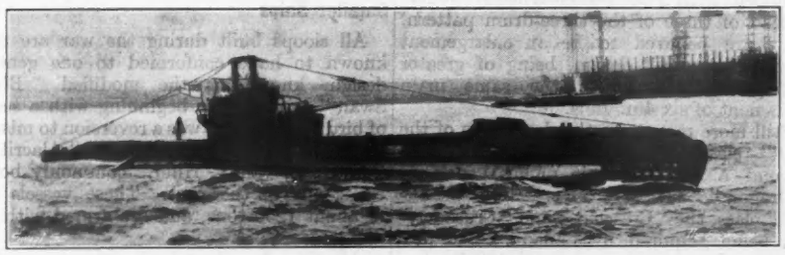
In the meantime, a large number of fleet aircraft carriers of a light intermediate type are passing into service. The first five, the "Colossus," "Glory," "Ocean," "Venerable," and "Vengeance," were all completed before the war with Japan came to an end; four were actually operating with the Pacific Fleet on VJ-day. A feature of their design is air conditioning and special insulation for tropical service. Standard displacement of these five ships is 14,000 tons; dimensions, 695ft. overall, 80ft. beam, and 23ft. mean draught; and speed, with two-shaft geared turbines and four boilers, 25 knots. Their full complement of aircraft is reported to be thirty-nine. The armament consists of twenty-four 2-pounder pompoms, supplemented by numerous 20-mm. Oerlikons.

In appearance these carriers are more symmetrical and therefore more attractive to the eye than any of their predecessors, as the illustrations in the Supplement show. To what extent later ships of the series will differ from the first five is uncertain, though it has been reported that the majority, if not all, will be of about 4000 tons greater displacement and slightly higher speed. The names of sixteen more have been published, but it is questionable whether all of them have been laid down yet. Two, the "Magnificent" and "Warrior," are being taken over by the Royal Canadian Navy.

H.M. TANKER "BLACK RANGER"

There are besides two other units of this group, H.M.S. "Perseus" (ex "Edgar") and "Pioneer" (ex "Mars"), which have been completed to a different design and are rated as aircraft maintenance ships. They would seem to be modified versions of the "Unicorn," begun under the 1938 programme as an aircraft repair ship, and completed with a flight deck. The invaluable service rendered by the "Unicorn" during the war is understood to have inspired the alteration in the *rôle* of these two ships, which were both built by Vickers-Armstrongs, Ltd., the "Perseus" at Walker, and the "Pioneer" at Barrow.

Several months ago it was disclosed that the fleet carriers "Indefatigable" and "Implacable," instead of being replicas of the 23,000-ton "Indomitable," are ships of 30,000 tons, of a greatly improved design. They are, in fact, the two largest carriers in service under the White Ensign, and were bigger than any in the United States fleet, other than the obsolescent "Saratoga," when they arrived in the Pacific. They are propelled by Parsons single-reduction geared turbines, driving four shafts, steam being supplied from eight Admiralty three-drum type boilers. Speed is believed to be at least 32 knots. These two ships differ from the "Indomitable" in having a larger funnel, no control tower before the foremast, and a short tripod mainmast stepped at the after end of the island superstructure. Armament does not vary appreciably from that of the earlier ship, comprising sixteen 4·5in. dual-purpose guns and numerous lighter weapons. No official information is available concerning the number of aircraft accommodated.



H.M. SUBMARINE "SAGA"

Cruisers

New cruisers recently completed or about to pass into service are the "Defence," "Superb," and "Swiftsure," of which the last-named was in service with the Pacific Fleet when the war with Japan came to an end. Of 8000 tons displacement, these cruisers do not differ materially from the "Ceylon" type preceding them, except that their design excludes a hangar or other provision for aircraft. H.M.C.S. "Ontario" (ex "Minotaur") is another unit of this class.

Slightly larger, apparently, are the four ships of the "Tiger" class (the other three being the "Bellerophon," "Blake," and "Hawke"), still under construction. Their displacement has been officially given as 8885 tons, the beam and draught being correspondingly increased. The armament of nine 6in. guns in three triple turrets and ten 4in. in pairs is the same as in the "Swiftsure." There is no word of any other cruisers having been ordered, in spite of the large proportion of our existing cruiser strength due for replacement; and it would seem as though the numerous light fleet carriers are regarded as a substitute.

Destroyers

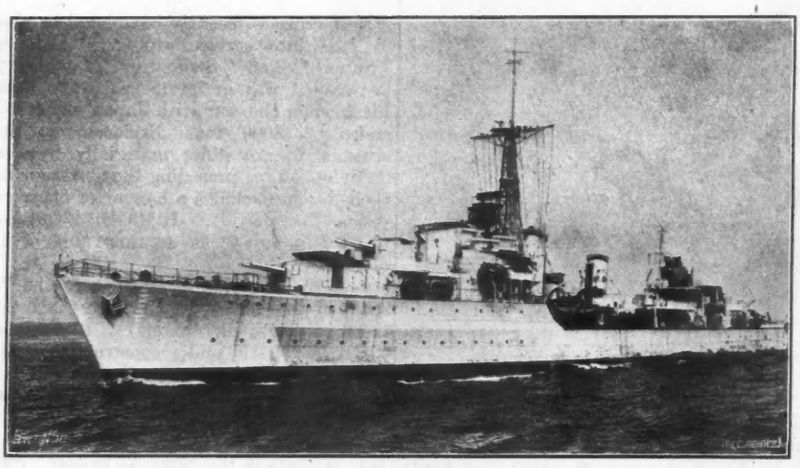
Destroyers continue to be turned out in large numbers. After the eight comprising the "Zealous" class, no fewer than thirty-two were put in hand belonging to the next alphabetical group, the "C" class, reported to be over 2000 tons displacement. As no "X," "Y," "A," or "B" classes were included in the war programme, this should occasion no surprise. Still more numerous are the destroyers of the "Battle" class, running to forty names, but not all of these will be completed. Rather more than half are named after naval actions, the remainder after military victories. Ten were intended to have been fitted as flotilla leaders, comprising five naval and five military names.

Unlike the destroyers which have preceded them, the "Battles" are of a new design. Instead of being armed with four 4·7in. dual-purpose guns in single mounts, two forward and two aft, the same number of guns, 4·5in. dual-purpose, are arranged in twin gun-houses forward. Astern fire is limited to eight 40-mm. Bofors anti-aircraft pieces. Although this arrangement has been criticised, being compared unfavourably with the six 5in. dual-purpose guns in twin mounts carried by the U.S. destroyers of the "Allen M. Sumner" and "Gearing" classes, of

"CHALLENGER" CRUISER TANK
"VALENTINE" SCISSORS BRIDGE
"HEAVY CHURCHILL" INFANTRY TANK

similar dimensions, it is said that the "Battle" type has acquitted itself well against dive-bombing and Kamikaze attacks.

Following the "Battles" come the "Weapons" class, of which sixteen are understood to be under construction; these include H.M.S. "Crossbow," the hundredth destroyer to be launched by Messrs. Thornycroft for the Royal Navy. These ships differ from the preceding class, in that they have their turbines arranged *en échelon*, and are equipped with two Foster-Wheeler boilers instead of three of the three-drum pattern. They are believed to be an enlargement of the "Brecon" design, being of greater displacement, but with the same main armament of six 4in. guns.



H.M. CANADIAN DESTROYER "MICMAC"

Still more recent are the destroyers of the "D" class, of which nothing is known beyond a few of their names, such as "Dragon," "Daring," &c. Two of the "C" class, the "Crescent" and "Crusader," are being acquired by Canada. The proposed construction of a new "G" class appears to have been abandoned.

Submarines

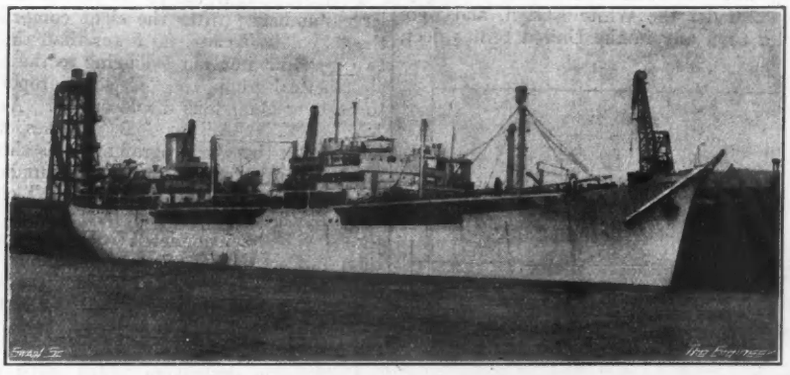
In submarines, wartime construction exceeded achievements in almost every category, and went far beyond replacing losses, heavy though those were. There are over forty of the "T" class, a similar number of the "S" class, and fifty of the "U" class. In addition, the new "A" class, understood to be an enlargement of the "T" type, is making good progress, half a dozen having already been launched. If the original programme is adhered to, there will be over forty of this series, which will be the largest modern submarines in the Navy. No trouble has been spared to incorporate in their design the best features of enemy craft that have passed through British hands.

Though only limited particulars have been released concerning the midget "X" type, it would appear from Press references that it is subdivided into two or three varieties, as some bearing numerals preceded by "XE" and "XT" have been mentioned.

Smaller Ships

All sloops built during the war are now known to have conformed to one general design, known as the modified "Black Swan" type. After beginning with a series of bird names, there was a reversion to miscellaneous appellations, such as "Alacrity," "Nymphe," and "Hind," commonly borne by sloops in the past. These vessels are of about 1250 tons, and are armed with six 4in. guns.

All the American-built frigates of the "Colony" and "Captain" classes, nearly one hundred in all, are being returned to the United States Navy under the terms of the lend-lease scheme. This leaves about the same number of British-built frigates in service. Of these, the latest are the "Bay" class (See Supplement), of the same dimensions as the "Loch" type that preceded them, but with a heavier armament. The "Lochs" mounted one 4in. high-angle gun, one quadruple pompom, and eight 20-mm. Oerlikons, whereas the "Bays" are reported to have four 4in., six 40-mm. Bofors, and four 20-mm. Oerlikons.



H.M. ELECTRICALLY PROPELLED TANKER "OLNA"

Though a good many of the "Castle" type corvettes are still in commission, most of the "Flowers" appear to have been laid up or placed in reserve, and it may not be long before they go on the disposal list. Fifteen escort vessels of the "Kil" class have proved to be ex-American submarine chasers of the "PCE" type, of nearly 800 tons displacement; it may be assumed that these will soon return across the Atlantic, if indeed they have not already gone. This applies also to the seventeen fleet minesweepers of the "Gazelle" class.

There appear to be nearly ninety of the highly efficient "Algerine" type in service, many of the more recent units having been built in Canada. In comparison with the "Bangors," these ships are not only larger, but able to keep the sea in heavier weather. In fact, the only point on which they have been criticised is their speed, said to be no more than 15 knots.

A type about which nothing had been heard until recently is the so-called "steam gunboat," of which six examples still exist, named "Grey Fox," "Grey Goose," &c. With a displacement of 250 tons, they are propelled by geared turbines of 8000 S.H.P. at a speed of over 30 knots. Lately some of these craft have been adapted for minesweeping.

For attendance on the Pacific Fleet a considerable number of repair and maintenance ships were completed. In addition to the "Assistance" group, mentioned in these columns a year ago, there are others named after headlands, inlets, and channels, such as "Berry Head," "Mull of Galloway," "Mullion Cove," "Deer Sound" (ex "Port Quebec"), and "Woodbridge Haven" (ex "Loch Torridon").

New oilers include five of the "Wave" class, of over 8000 tons gross, and at least one of a special turbo-electric design, acquired by the Admiralty from the Anglo-Saxon Petroleum Company, Ltd., the "Olna." Of over 12,500 tons gross, these fine ships have a designed speed of 17 knots with 13,000 S.H.P., considerably greater than usual in Admiralty oilers. Construction of a number of smaller oilers is in hand, reviving former names, such as "Birchol" and "Oakol."

Coastal tank vessels built during the war include the "Spa" series of four water carriers of 1200 tons displacement, built by Messrs. Philip and Son, Ltd.

The latest rescue tugs are the six of the "Envoy" class, all built by Cochrane and Sons. These have a displacement of 1332 tons and are propelled by triple-expansion engines of 1700 I.H.P., giving a speed in service of 13 knots.

Dominion Navies

With the end of the war the Royal Canadian Navy has lost no time in disposing of its surplus ships. As many as seventy corvettes are reported to have been advertised for sale in one batch, and it is proposed that the post-war fleet shall consist of two aircraft carriers, the "Warrior" and "Magnificent"; two cruisers, the "Ontario" and "Uganda"; about a dozen destroyers, eighteen frigates, twelve minesweepers of the "Algerine" type, and some smaller craft.

The Royal Indian Navy, in addition to six war-built sloops, has acquired from the Admiralty three frigates of the "River" type and four corvettes of the improved "Flower" design. There are also sixteen fleet minesweepers of "Bangor" or "Bathurst" type.

In the South African Naval Force there are now three frigates of the "Loch" class and one of the "River" class.

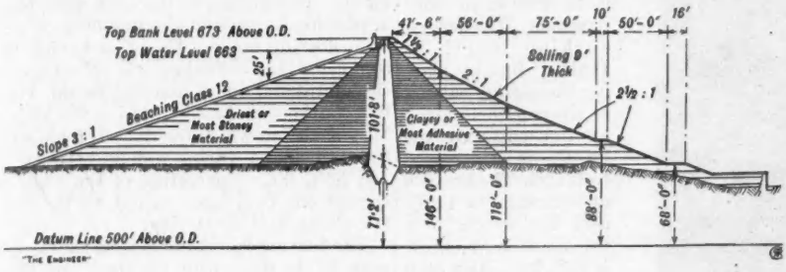
(To be continued)

Civil Engineering in 1945

No. I

IN an article on "Civil Engineering in 1944," published at this time last year, we looked back to 1944 with pride in the achievements of engineers at war and distress at the scale of destruction of engineering works that war had brought about. To 1945 we looked forward with the hope that it would bring at least an end to the war in Europe. That optimism was justified by events, and, indeed, the rapid subsequent collapse of Japan exceeded all expectations. But, despite the evanescent joy in victory and a more lasting satisfaction in the recovery of peace, it is still not possible to look back on 1945 without distress nor forward to 1946 without trepidation. For it is not until a war is over, until censorship is relaxed, and until the attempt is made to pick up the threads of peacetime activities uninfluenced by the stimulation and excitement of war, that the real extent of the damage becomes apparent. Even in this country, which has been spared many of the greater sufferings of those over which the competing armies actually fought, recovery must inevitably be slow. But here it is in the main lack of manpower available to undertake the task of converting industry back to a peacetime basis that limits supplies, causes our trains to be overcrowded, and, for lack of fuel, keeps our buildings cold. On the Continent it is far otherwise. There has been serious destruction of buildings, factories, and plant, and all kinds of transport have been thrown into disorder. Thus, even where manpower is available, material for repairs often is not. Railways operate with antiquated, ill-maintained, and insufficient rolling stock over hastily repaired permanent way. They suffer the ills of broken bridges, wrecked embankments, and disorganised shunting yards. Canals, so much more important on the Continent than in this island, are often rendered impassible even if the locks remain firm, by the wrecks of bridges and of barges and other craft. Though roads still remain in reasonable repair, there are neither sufficient vehicles to run on them nor the petrol available, could vehicles be found. The development of power is hindered by damaged hydro-electric and steam plants and insufficient supplies of coal. In certain urban areas supplies of water and gas are maintained only with difficulty. Ports through which much-needed supplies might be brought from abroad, were shipping available, are hampered by lack of equipment, blocked by sunken wrecks, and have access to them rendered difficult by still existing minefields.

It is against such a background of destruction and disorder that the work of civil engineers in 1945 must be considered. In the early part of the year they were still concerned principally with wartime work. Only towards its end were they able to turn their thoughts to the detailed consideration of future peacetime projects. But for many years to come the activities of many engineers will have to be directed towards the work of repair and rebuilding rather than towards the execution of new works.



SECTION THROUGH LADYBOWER DAM

Britain

Only one civil engineering scheme of major importance seems to have been brought to completion in this country during 1945. On September 25th the third instalment of works in the Derwent Valley for the supply of water to Sheffield, Nottingham, Leicester, and Derby was inaugurated by the Derwent Valley Water Board. The works thus brought into use consist of the Ladybower dam and intake and appurtenant works. The dam blocks the Derwent Valley downstream from two existing structures, the Derwent and Howden dams respectively, creating a reservoir with a capacity when full of 6300 million gallons. A section through the dam is reproduced in an accompanying drawing, from which it will be seen that an earthwork embankment with a clay core and a concrete cut-off wall has been adopted. The cut-off wall extends below the dam to an average depth of 180ft. and a maximum depth of 255ft. to reach bedrock. From the bottom of the cut-off trench and its extension into the side walls of the valley cement grout was injected to the extent of 13,000 tons to seal the strata.

The dam, which is illustrated in a Supplement to this issue, has a length of 1250ft. and a maximum thickness of 665ft. It holds the water up to a depth of 135ft. above stream level. For the discharge of flood waters there are two spillways with 80ft. diameter bell-mouths placed one near each end of the dam and discharging through tunnels under the dam. Two intake valve shafts provide for drawing off water at three different levels. The pipes lead to valve houses at the downstream base of the dam, at which the quantity discharged can be measured and controlled. At present the reservoir is being used solely for the supply of compensation water to the River Derwent, thus relieving the reservoirs upstream of that duty and enhancing the supply available from them.

ASHOPTON VIADUCT UNDER CONSTRUCTION ACROSS ARM OF LADYBOWER RESERVOIR

tion in our Supplement. Seventy of these engines are being built, and they will be known as the "West Country" class. For them a new nomenclature has been adopted—"21C100"—a distinct departure from usual means of locomotive classification. In it, the "2" stands for the first pair of axles, the "1" for the trailing axle, "C" three driving axles, and "100" is the number of the engine in its class. Some of their leading particulars are as follows:—Cylinders (three simple), 16½in. by 24in.; pressure, 280 lb. per square inch; driving wheel diameter, 6ft. 2in.; heating surface: evaporative, 2122 square feet; and superheating, 545 square feet; grate area, 38·25 square feet; weight on drivers, 18 tons 15 cwt.; on bogie, 15 tons 10 cwt.; on trailer, 14 tons 6 cwt.; tractive effort at 85 per cent. pressure, 31,000 lb. Following Mr. Bulleid's interesting paper, before the Institution of Mechanical Engineers, on the construction of the "Merchant Navy" engines, which was reprinted in our issues of December 21st and 28th, we look forward to an equally absorbing description of the design and building of the "West Country" locomotives.

London and North-Eastern Railway

The first engine of the London and North-Eastern Railway Company's five-year locomotive building plan is the 2–6–4 tank engine "No. 9000," which is illustrated on page 17. It has been designed to meet the operating department's need for an engine with a considerably larger water capacity than the existing 2–6–2 locomotives, and yet be within restricted axle loading. These engines, of which there are to be 110, have been built to the plans of Mr. Edward Thompson and are the first 2–6–4s made by the company. Their coupled wheels are 5ft. 2in. diameter and, although smaller than is usual for engines on passenger work, are ample for the maximum speeds likely to be required. At the same time, this size ensures the rapid starting and acceleration essential to suburban working, and also adapts the locomotive for heavy mineral haulage. Designed for a working pressure of 225 lb. per square inch, it is claimed that the tractive effort of 32,000 lb., of which the engines are capable, is the highest for their type in this country. Its tanks and bunker are of welded construction and hold 2650 gallons of water and 4½ tons of coal. In order to meet the requirements of the company's eastern section, full Westinghouse braking and a vacuum ejector have been fitted.

During the year the oldest "Pacific" locomotive of the company—No. 1470, "Great Northern"—was completely rebuilt and modernised. The leading particulars of the rebuilt engine, with the original dimensions in brackets, are as follows:—Cylinders, three, 19in. by 26in. (20in. by 26in.); maximum cut-off, 75 per cent. (65 per cent.); maximum valve travel, 6 11/16in. (5¾in.); coupled wheel diameter, 6ft. 8in. (6ft. 8in.); total heating surface, 3325·2 square feet (3455 square feet); boiler pressure, 250 lb. per square inch (180 lb.); tractive effort, 37,397 lb. (29,835 lb.); adhesive weight, 147,840 lb. (134,400 lb.); adhesive factor, 3·95 (4·5). The original engine was fitted with Walschaerts outside and Gresley inside valve gear, and in the rebuilt locomotive, in place of the conjugated 2–1 levers actuating the crank valve, an independent set of Walschaerts gear is provided. This gear is operated by an excentric having a throw of 4½in., mounted on the crank axle. The standard type of built-up crank axle with balance weights, formed by extension of the crank webs, is now fitted on the leading coupled wheels, and is driven by the inside cylinder. Exhaust from the outside cylinders passes along the outside of the frames and enters the inside cylinder casing, where it joins the inside exhaust at the blast pipe base and passes on into a double chimney. A picture of the rebuilt engine, which has been renumbered 4470, appears on page 17.

During the year the L.N.E.R. rebuilt a number of three-cylinder engines with two cylinders, in which the Gresley valve gear is eliminated. At the same time, opportunity was taken to fit the rebuilt engines with new boilers having an increased working pressure. This increase in pressure coupled with larger cylinders, has made it possible to retain practically the same tractive effort on the converted engines.

London Midland and Scottish Railway

Forty-five 2–6–4 tank engines of improved design are under construction at the Derby works of the London Midland and Scottish Railway Company, and one of them is shown in the illustration on page 16. These engines are used for all sorts of freight and suburban work and, if needed, are capable of working up to 70 m.p.h. with expresses. Although closely following the lines of existing locomotives, the new engines have a shorter wheel base of 15ft. 4in., which allows them freely to negotiate curves down to 5 chains. In order to compensate for this shortening and the increased weight per foot run, a number of economies in weight, totalling 3 tons 8 cwt., have been made.

(To be continued)

Naval Construction in 1945

By FRANCIS McMURTRIE, A.I.N.A.

No. I

British Navy

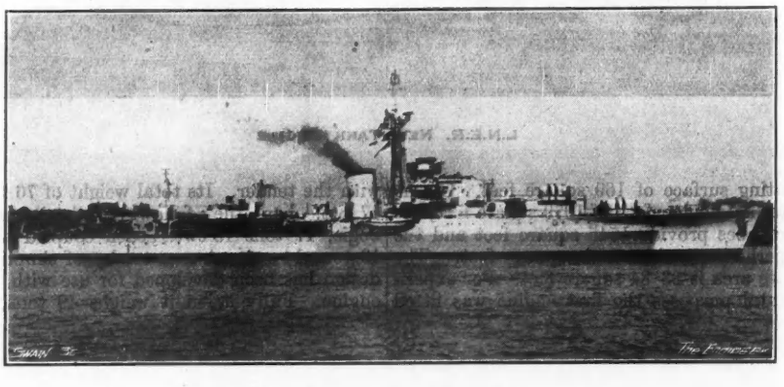
THOUGH censorship came to an end some months ago, particulars of the majority of ships built for the Royal Navy during the war have still to be released in full. Nor is it always possible to obtain official confirmation of such details on the subject as may appear in the Press. It is well to make this observation, since otherwise some of the information in this article might be deemed unduly scanty.

Battleships

Little more is known about the latest British battleship, H.M.S. "Vanguard," than was available a year ago. An aerial photograph has been published, showing her fitting out in the yard of John Brown and Co., Ltd., at Clydebank; this suggests that she has two funnels and four main turrets. From the fact that she has been officially referred to as the largest warship ever built in these islands, it may be assumed that the reputed standard displacement of 45,000 tons is accurate; the most probable armament is eight 15in. guns. There is known to be a considerable reserve of guns of this calibre, consequent on the loss of H.M.S. "Hood," "Barham," and "Royal Oak," whose spares thus become available for disposal. This is likely to have dictated the choice of the 15in. calibre in preference to 14in., as mounted in the "King George V" type, or 16in., as in the "Nelson" and "Rodney."

A similar reason—the absence of a stock of 16in. guns—may have been partly responsible for the suspension of work on the four battleships authorised under the 1938 and 1939 Estimates, the "Lion," "Temeraire," "Conqueror," and "Thunderer." There has been no word of their construction having been resumed, and it may well be that after six years of war the original design has been discarded in favour of new plans based upon operational experience.

As in 1919, there are many who contend that battleships are no longer needed, and who therefore oppose their construction. It is not proposed to enter into this controversy here, but it may be pointed out that in the United States Navy official views do not seem to support the above interpretation of the events of the Second World War.



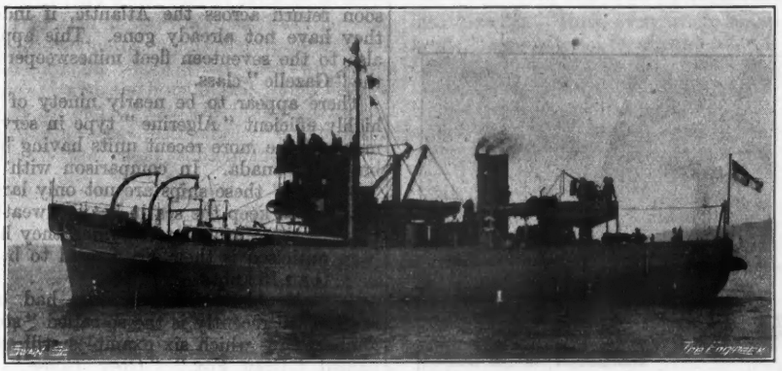
H.M. DESTROYER "ARMADA"

Aircraft Carriers

How many aircraft carriers are being built it is impossible to ascertain with exactitude. Three very large ones, said to be comparable with the 45,000-ton "Midway" type in the United States Navy, were to have been named "Gibraltar," "Malta," and "New Zealand." Orders are understood to have been placed for these ships with Vickers-Armstrongs, Ltd., Walker-on-Tyne; John Brown and Co., Ltd., Clydebank; and Cammell Laird and Co., Ltd., Birkenhead, respectively. Whether they will all be completed is questionable. A fourth ship which may belong to this class was to have been named "Africa," but it is doubtful whether she has gone beyond the projected stage.

Contracts are believed to have been placed two or three years ago for H.M.S. "Ark

Royal," "Audacious," and "Eagle," under construction at the yards of Cammell Laird and Co., Ltd., Harland and Wolff, Ltd., and Vickers-Armstrongs, Ltd. (Tyne), respectively. Known as the "Eagle" class, these ships are understood to displace about 33,000 tons. They are to be propelled by four-shaft turbines of the Parsons type with single-reduction gearing, steam being supplied from boilers of the Admiralty three-drum design. None of these ships has yet been launched.



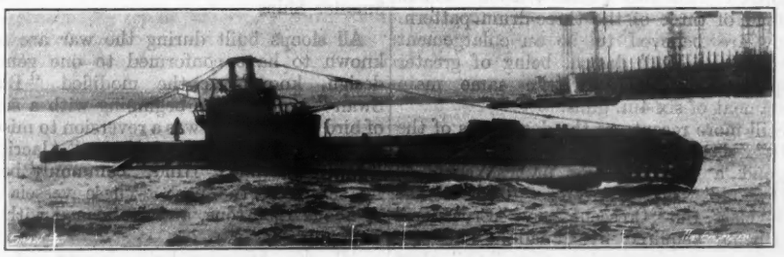
COASTAL MINELAYER

In the meantime, a large number of fleet aircraft carriers of a light intermediate type are passing into service. The first five, the "Colossus," "Glory," "Ocean," "Venerable," and "Vengeance," were all completed before the war with Japan came to an end; four were actually operating with the Pacific Fleet on VJ-day. A feature of their design is air conditioning and special insulation for tropical service. Standard displacement of these five ships is 14,000 tons; dimensions, 695ft. overall, 80ft. beam, and 23ft. mean draught; and speed, with two-shaft geared turbines and four boilers, 25 knots. Their full complement of aircraft is reported to be thirty-nine. The armament consists of twenty-four 2-pounder pompoms, supplemented by numerous 20-mm. Oerlikons.

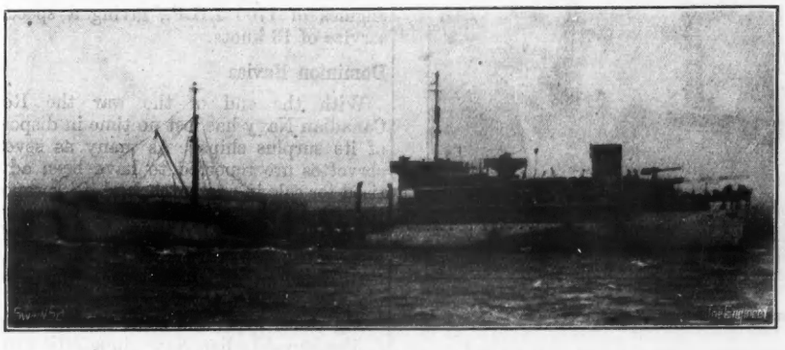
In appearance these carriers are more symmetrical and therefore more attractive to the eye than any of their predecessors, as the illustrations in the Supplement show. To what extent later ships of the series will differ from the first five is uncertain, though it has been reported that the majority, if not all, will be of about 4000 tons greater displacement and slightly higher speed. The names of sixteen more have been published, but it is questionable whether all of them have been laid down yet. Two, the "Magnificent" and "Warrior," are being taken over by the Royal Canadian Navy.

There are besides two other units of this group, H.M.S. "Perseus" (ex "Edgar") and "Pioneer" (ex "Mars"), which have been completed to a different design and are rated as aircraft maintenance ships. They would seem to be modified versions of the "Unicorn," begun under the 1938 programme as an aircraft repair ship, and completed with a flight deck. The invaluable service rendered by the "Unicorn" during the war is understood to have inspired the alteration in the *rôle* of these two ships, which were both built by Vickers-Armstrongs, Ltd., the "Perseus" at Walker, and the "Pioneer" at Barrow.

Several months ago it was disclosed that the fleet carriers "Indefatigable" and "Implacable," instead of being replicas of the 23,000-ton "Indomitable," are ships of 30,000 tons, of a greatly improved design. They are, in fact, the two largest carriers in service under the White Ensign, and were bigger than any in the United States fleet, other than the obsolescent "Saratoga," when they arrived in the Pacific. They are propelled by Parsons single-reduction geared turbines, driving four shafts, steam being supplied from eight Admiralty three-drum type boilers. Speed is believed to be at least 32 knots. These two ships differ from the "Indomitable" in having a larger funnel, no control tower before the foremast, and a short tripod mainmast stepped at the after end of the island superstructure. Armament does not vary appreciably from that of the earlier ship, comprising sixteen 4·5in. dual-purpose guns and numerous lighter weapons. No official information is available concerning the number of aircraft accommodated.



H.M. SUBMARINE "SAGA"



H.M. TANKER "BLACK RANGER"

Cruisers

New cruisers recently completed or about to pass into service are the "Defence," "Superb," and "Swiftsure," of which the last-named was in service with the Pacific Fleet when the war with Japan came to an end. Of 8000 tons displacement, these cruisers do not differ materially from the "Ceylon" type preceding them, except that their design excludes a hangar or other provision for aircraft. H.M.C.S. "Ontario" (ex "Minotaur") is another unit of this class.

Slightly larger, apparently, are the four ships of the "Tiger" class (the other three being the "Bellerophon," "Blake," and "Hawke"), still under construction. Their displacement has been officially given as 8885 tons, the beam and draught being correspondingly increased. The armament of nine 6in. guns in three triple turrets and ten 4in. in pairs is the same as in the "Swiftsure." There is no word of any other cruisers having been ordered, in spite of the large proportion of our existing cruiser strength due for replacement; and it would seem as though the numerous light fleet carriers are regarded as a substitute.

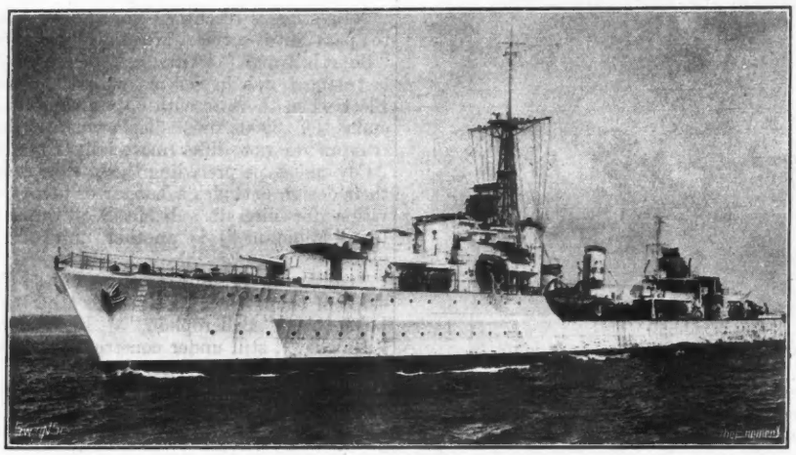
Destroyers

Destroyers continue to be turned out in large numbers. After the eight comprising the "Zealous" class, no fewer than thirty-two were put in hand belonging to the next alphabetical group, the "C" class, reported to be over 2000 tons displacement. As no "X," "Y," "A," or "B" classes were included in the war programme, this should occasion no surprise. Still more numerous are the destroyers of the "Battle" class, running to forty names, but not all of these will be completed. Rather more than half are named after naval actions, the remainder after military victories. Ten were intended to have been fitted as flotilla leaders, comprising five naval and five military names.

Unlike the destroyers which have preceded them, the "Battles" are of a new design. Instead of being armed with four 4·7in. dual-purpose guns in single mounts, two forward and two aft, the same number of guns, 4·5in. dual-purpose, are arranged in twin gun houses forward. Astern fire is limited to eight 40-mm. Bofors anti-aircraft pieces. Although this arrangement has been criticised, being compared unfavourably with the six 5in. dual-purpose guns in twin mounts carried by the U.S. destroyers of the "Allen M. Sumner" and "Gearing" classes, of

similar dimensions, it is said that the "Battle" type has acquitted itself well against dive-bombing and Kamikaze attacks.

Following the "Battles" come the "Weapons" class, of which sixteen are understood to be under construction; these include H.M.S. "Crossbow," the hundredth destroyer to be launched by Messrs. Thornycroft for the Royal Navy. These ships differ from the preceding class, in that they have their turbines arranged *en échelon*, and are equipped with two Foster-Wheeler boilers instead of three of the three-drum pattern. They are believed to be an enlargement of the "Brecon" design, being of greater displacement, but with the same main armament of six 4in. guns.



H.M. CANADIAN DESTROYER "MICMAC"

Still more recent are the destroyers of the "D" class, of which nothing is known beyond a few of their names, such as "Dragon," "Daring," &c. Two of the "C" class, the "Crescent" and "Crusader," are being acquired by Canada. The proposed construction of a new "G" class appears to have been abandoned.

Submarines

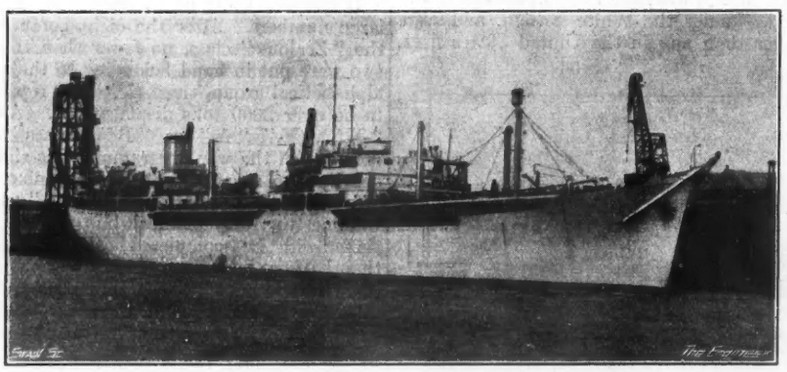
In submarines, wartime construction exceeded achievements in almost every category, and went far beyond replacing losses, heavy though those were. There are over forty of the "T" class, a similar number of the "S" class, and fifty of the "U" class. In addition, the new "A" class, understood to be an enlargement of the "T" type, is making good progress, half a dozen having already been launched. If the original programme is adhered to, there will be over forty of this series, which will be the largest modern submarines in the Navy. No trouble has been spared to incorporate in their design the best features of enemy craft that have passed through British hands.

Though only limited particulars have been released concerning the midget "X" type, it would appear from Press references that it is subdivided into two or three varieties, as some bearing numerals preceded by "XE" and "XT" have been mentioned.

Smaller Ships

All sloops built during the war are now known to have conformed to one general design, known as the modified "Black Swan" type. After beginning with a series of bird names, there was a reversion to miscellaneous appellations, such as "Alacrity," "Nymphe," and "Hind," commonly borne by sloops in the past. These vessels are of about 1250 tons, and are armed with six 4in. guns.

All the American-built frigates of the "Colony" and "Captain" classes, nearly one hundred in all, are being returned to the United States Navy under the terms of the lend-lease scheme. This leaves about the same number of British-built frigates in service. Of these, the latest are the "Bay" class (See Supplement), of the same dimensions as the "Loch" type that preceded them, but with a heavier armament. The "Lochs" mounted one 4in. high-angle gun, one quadruple pompom, and eight 20-mm. Oerlikons, whereas the "Bays" are reported to have four 4in., six 40-mm. Bofors, and four 20-mm. Oerlikons.



H.M. ELECTRICALLY PROPELLED TANKER "OLNA"

Though a good many of the "Castle" type corvettes are still in commission, most of the "Flowers" appear to have been laid up or placed in reserve, and it may not be long before they go on the disposal list. Fifteen escort vessels of the "Kil" class have proved to be ex-American submarine chasers of the "PCE" type, of nearly 800 tons displacement; it may be assumed that these will soon return across the Atlantic, if indeed they have not already gone. This applies also to the seventeen fleet minesweepers of the "Gazelle" class.

There appear to be nearly ninety of the highly efficient "Algerine" type in service, many of the more recent units having been built in Canada. In comparison with the "Bangors," these ships are not only larger, but able to keep the sea in heavier weather. In fact, the only point on which they have been criticised is their speed, said to be no more than 15 knots.

A type about which nothing had been heard until recently is the so-called "steam gunboat," of which six examples still exist, named "Grey Fox," "Grey Goose," &c. With a displacement of 250 tons, they are propelled by geared turbines of 8000 S.H.P. at a speed of over 30 knots. Lately some of these craft have been adapted for minesweeping.

For attendance on the Pacific Fleet a considerable number of repair and maintenance ships were completed. In addition to the "Assistance" group, mentioned in these columns a year ago, there are others named after headlands, inlets, and channels, such as "Berry Head," "Mull of Galloway," "Mullion Cove," "Deer Sound" (ex "Port Quebec"), and "Woodbridge Haven" (ex "Loch Torridon").

New oilers include five of the "Wave" class, of over 8000 tons gross, and at least one of a special turbo-electric design, acquired by the Admiralty from the Anglo-Saxon Petroleum Company, Ltd., the "Olna." Of over 12,500 tons gross, these fine ships have a designed speed of 17 knots with 13,000 S.H.P., considerably greater than usual in Admiralty oilers. Construction of a number of smaller oilers is in hand, reviving former names, such as "Birchol" and "Oakol."

Coastal tank vessels built during the war include the "Spa" series of four water carriers of 1200 tons displacement, built by Messrs. Philip and Son, Ltd.

The latest rescue tugs are the six of the "Envoy" class, all built by Cochrane and Sons. These have a displacement of 1332 tons and are propelled by triple-expansion engines of 1700 I.H.P., giving a speed in service of 13 knots.

Dominion Navies

With the end of the war the Royal Canadian Navy has lost no time in disposing of its surplus ships. As many as seventy corvettes are reported to have been advertised for sale in one batch, and it is proposed that the post-war fleet shall consist of two aircraft carriers, the "Warrior" and "Magnificent"; two cruisers, the "Ontario" and "Uganda"; about a dozen destroyers, eighteen frigates, twelve minesweepers of the "Algerine" type, and some smaller craft.

The Royal Indian Navy, in addition to six war-built sloops, has acquired from the Admiralty three frigates of the "River" type and four corvettes of the improved "Flower" design. There are also sixteen fleet minesweepers of "Bangor" or "Bathurst" type.

In the South African Naval Force there are now three frigates of the "Loch" class and one of the "River" class.

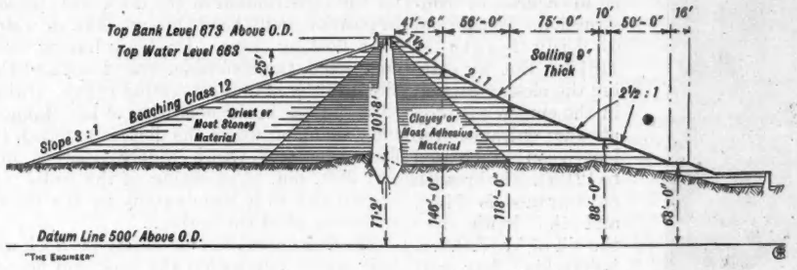
(To be continued)

Civil Engineering in 1945

No. I

IN an article on "Civil Engineering in 1944," published at this time last year, we looked back to 1944 with pride in the achievements of engineers at war and distress at the scale of destruction of engineering works that war had brought about. To 1945 we looked forward with the hope that it would bring at least an end to the war in Europe. That optimism was justified by events, and, indeed, the rapid subsequent collapse of Japan exceeded all expectations. But, despite the evanescent joy in victory and a more lasting satisfaction in the recovery of peace, it is still not possible to look back on 1945 without distress nor forward to 1946 without trepidation. For it is not until a war is over, until censorship is relaxed, and until the attempt is made to pick up the threads of peacetime activities uninfluenced by the stimulation and excitement of war, that the real extent of the damage becomes apparent. Even in this country, which has been spared many of the greater sufferings of those over which the competing armies actually fought, recovery must inevitably be slow. But here it is in the main lack of manpower available to undertake the task of converting industry back to a peacetime basis that limits supplies, causes our trains to be overcrowded, and, for lack of fuel, keeps our buildings cold. On the Continent it is far otherwise. There has been serious destruction of buildings, factories, and plant, and all kinds of transport have been thrown into disorder. Thus, even where manpower is available, material for repairs often is not. Railways operate with antiquated, ill-maintained, and insufficient rolling stock over hastily repaired permanent way. They suffer the ills of broken bridges, wrecked embankments, and disorganised shunting yards. Canals, so much more important on the Continent than in this island, are often rendered impassible even if the locks remain firm, by the wrecks of bridges and of barges and other craft. Though roads still remain in reasonable repair, there are neither sufficient vehicles to run on them nor the petrol available, could vehicles be found. The development of power is hindered by damaged hydro-electric and steam plants and insufficient supplies of coal. In certain urban areas supplies of water and gas are maintained only with difficulty. Ports through which much-needed supplies might be brought from abroad, were shipping available, are hampered by lack of equipment, blocked by sunken wrecks, and have access to them rendered difficult by still existing minefields.

It is against such a background of destruction and disorder that the work of civil engineers in 1945 must be considered. In the early part of the year they were still concerned principally with wartime work. Only towards its end were they able to turn their thoughts to the detailed consideration of future peacetime projects. But for many years to come the activities of many engineers will have to be directed towards the work of repair and rebuilding rather than towards the execution of new works.

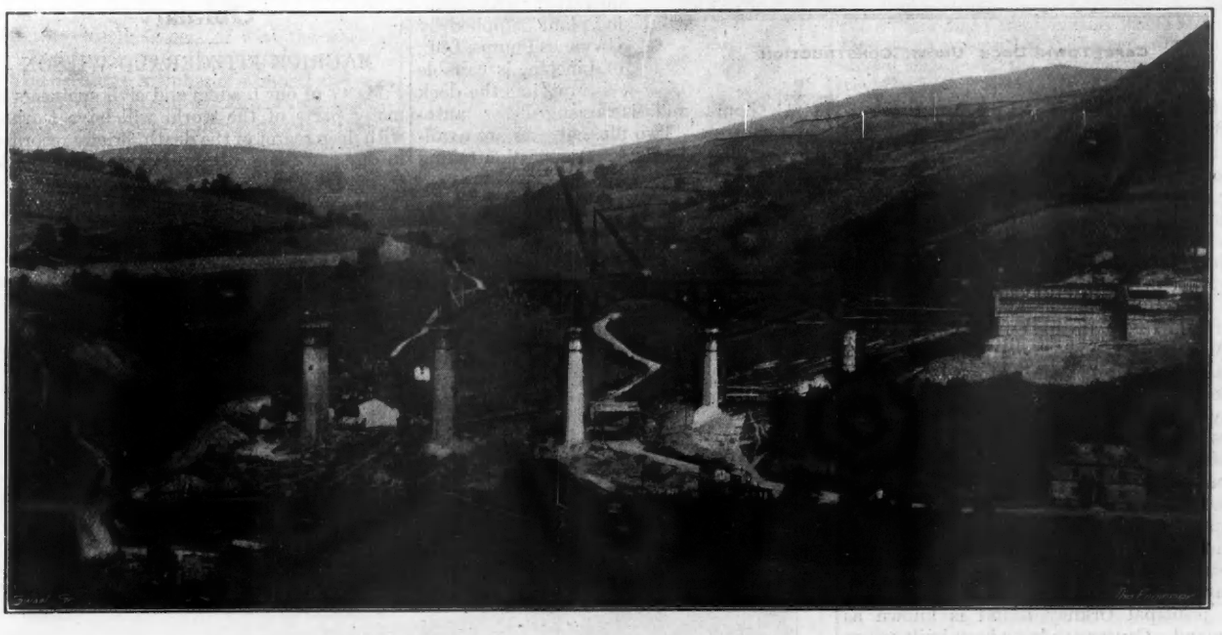


SECTION THROUGH LADYBOWER DAM

Britain

Only one civil engineering scheme of major importance seems to have been brought to completion in this country during 1945. On September 25th the third instalment of works in the Derwent Valley for the supply of water to Sheffield, Nottingham, Leicester, and Derby was inaugurated by the Derwent Valley Water Board. The works thus brought into use consist of the Ladybower dam and intake and appurtenant works. The dam blocks the Derwent Valley downstream from two existing structures, the Derwent and Howden dams respectively, creating a reservoir with a capacity when full of 6300 million gallons. A section through the dam is reproduced in an accompanying drawing, from which it will be seen that an earthwork embankment with a clay core and a concrete cut-off wall has been adopted. The cut-off wall extends below the dam to an average depth of 180ft. and a maximum depth of 255ft. to reach bedrock. From the bottom of the cut-off trench and its extension into the side walls of the valley cement grout was injected to the extent of 13,000 tons to seal the strata.

The dam, which is illustrated in a Supplement to this issue, has a length of 1250ft. and a maximum thickness of 665ft. It holds the water up to a depth of 135ft. above stream level. For the discharge of flood waters there are two spillways with 80ft. diameter bell-mouths placed one near each end of the dam and discharging through tunnels under the dam. Two intake valve shafts provide for drawing off water at three different levels. The pipes lead to valve houses at the downstream base of the dam, at which the quantity discharged can be measured and controlled. At present the reservoir is being used solely for the supply of compensation water to the River Derwent, thus relieving the reservoirs upstream of that duty and enhancing the supply available from them.



ASHOPTON VIADUCT UNDER CONSTRUCTION ACROSS ARM OF LADYBOWER RESERVOIR

But an aqueduct carrying water from these reservoirs runs along the eastern side of the new reservoir at a higher level than its waters, and provision has been made for pumping water into it, the power for that operation to be mainly generated by the outflowing compensation water.

The water impounded in the new reservoir has flooded 2 miles of the original Glossop-Sheffield road, together with lengths of two other roads. Road diversions had therefore to be constructed and two of them are carried over arms of the reservoirs by large concrete viaducts, one of which is shown under construction in an accompanying engraving.

CAPE TOWN DOCK UNDER CONSTRUCTION

The whole of the works described, with the exception of the viaducts, was designed by and carried out under the supervision of Mr. H. P. Hill, of Messrs. G. H. Hill and Sons, of Manchester. The contractor was Mr. Richard Baillie, of Haddington. Mr. David Anderson, of Westminster, and Mr. William Keay, of Leicester, were the consulting engineers for the viaducts, which were constructed by Holloway Brothers (London), Ltd.

Another civil engineering work that should be mentioned, though strictly it was actually completed in 1944, is the connection of islands in the Orkney group by causeways. Information regarding this work was not released until the end of the war in Europe. The principal Orkney island is known as Mainland. Causeways have been built across Kirk, Skerry, Weddell, and Water Sounds to link South Ronaldshay over two other islands to Mainland. The work was undertaken to improve the fleet anchorage at Scapa Flow, and the causeways were formed by dumping 5-ton and 10-ton concrete blocks at random in the Sounds, through which strong tidal currents flow. Bolsters consisting of about 5 tons of local rock enclosed in large-mesh steel wire cages were also used. All the material was placed by means of cableways. Roads have been formed over the causeways to link the islands together. The total cost was about £2,000,000.

Large Docks

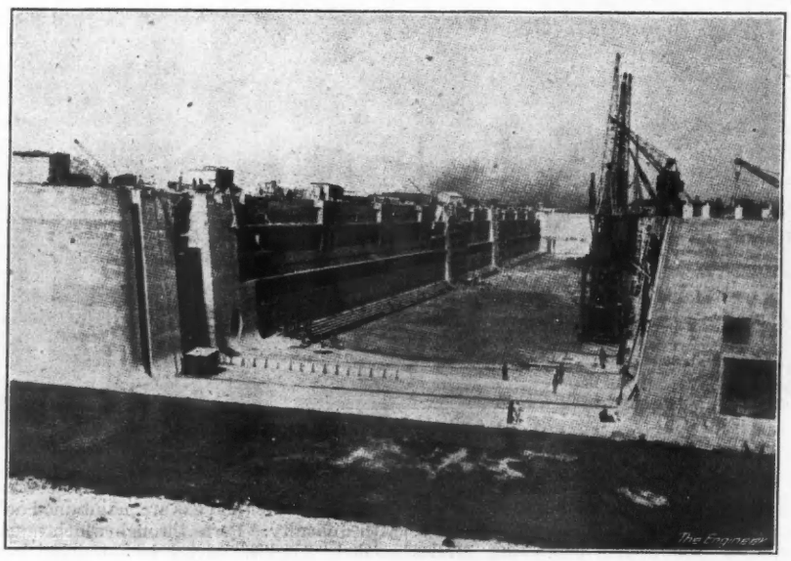
Two very large graving docks were completed during the year, one at Cape Town, South Africa, and the other at Sydney, Australia. Both are to be numbered amongst the largest in the world. The Cape Town dock was formally opened in September. A view of the completed structure is reproduced in the Supplement, and engravings on this page show it in course of construction. The normal docking length is 1181ft. But by placing the closing caisson in the emergency stop at the entrance the length can be increased to 1212ft. The breadth at entrance is 148ft. and the depth over the sill at H.W.O.S.T. is 45ft. 9in. Any craft at present afloat can be accommodated. Two inner caisson groynes are so arranged that the dock may be divided into lengths of 469ft. and 674ft. or, alternatively, 709ft. and 434ft. Eventually the dock will be commanded by one 50-ton crane, one 10-ton crane, and two 5-ton cranes, all electrically operated. The pumping plant, supplied by Gwynnes Pumps, Ltd., of Lincoln, is capable of emptying the dock in 4¼ hours and is arranged for automatic control. Two 9ft. culverts are available for filling the dock, an operation taking about 1¼ hours. All valves and pumping machinery are remote controlled from a control room fitted with a mimic diagram.

The dock was built by Hollandse Aaneming Maatskappy S.A. (Eindoms) Beperk, MacLaren and Eger (Pty.), Ltd., and Murray and Stewart (Pty.), Ltd., in association with the S.A. Railways Administration. It was designed in association with the British Admiralty and construction was under the supervision of J. S. de V. von Willick, Chief Civil Engineer, South African Railways. The first task was to build a reclamation dyke across a corner of the new Duncan dock. This work was done by dredgers. At the same time rock breakers and dredgers operated at the site of the graving dock. To ensure water-tightness of the dyke or cofferdam piling was driven through the dredged and dumped material to bedrock. Before closing the cofferdam four dockside cranes for the construction of the dock were placed in position at its head through 50ft. of water by a floating crane. Dredging having been completed, the cofferdam was closed and the site unwatered and concreting begun. Owing to variations in the condition of the Malmesbury shale, on which the dock is founded, its floor thickness varies widely between 6ft. and 35ft. 6in. Concreting of the walls was carried out to a large extent by the use of travelling steel shuttering.

The floating caisson for closing the dock was built in the dry within the dock and floated out when the dock was first flooded. The steelwork for this unit was fabricated by Sir William Arrol and Co., Ltd., and constructed by Dorman Long (Africa), Ltd. It weighs some 1200 tons. After testing the caisson the cofferdam was breached and dredgers then operated to back-fill behind the dock walls, whilst rock breakers and dredgers deepened the entrance channel to the dock.

The cost of the dock is estimated to reach £3,510,000.

(To be continued)



CAPE TOWN DOCK NEARLY COMPLETED

Obituary

MAURICE FITZGERALD WILSON

MANY of our readers and civil engineers in many parts of the world will have learned with deep regret of the death, briefly recorded in our last issue, of Mr. Maurice FitzGerald Wilson, the senior partner in the firm of Coode, Wilson, Vaughan-Lee and Gwyther, consulting civil engineers, of 9, Victoria Street, Westminster. In 1924, on the death

of Sir Maurice Fitzmaurice, who had joined the firm in 1912, he became senior partner, a position he continued to hold with distinction until his death.

Mr. Wilson, who at the time of his death, was in his eighty-seventh year, was educated at Eton, and in 1881 began his technical training as a civil engineer as an articled pupil to Sir John Coode. From 1883 until 1892 he was engaged on various dock, harbour and railway undertakings. As assistant engineer to Lucas and Aird, he worked on the Tilbury docks scheme, and also on the Bodmin and Wadebridge Railway. From 1892 until 1895 he was resident engineer at Southampton for the dock extension scheme carried out for the London and South-Western Railway Company under Mr. W. R. Galbraith.

In the following year Mr. Wilson was appointed superintending engineer in charge of the survey for the construction of the Admiralty harbour at Dover, and subsequently had charge of the construction of the works under the contract, on which he was engaged until 1905. In 1906 he joined the firm of Coode, Son and Matthews, of which Sir William Matthews was then the senior partner. For close upon forty years Mr. Wilson was actively engaged in the design and construction of harbours and docks, sea defence works, bridges, and barrages. Amongst these works were the design of the Admiralty harbour or refuge at Peterhead and numerous undertakings for the Crown Agents for the Colonies, many of which have been described and illustrated in the pages of THE ENGINEER. They included the construction of wharfage and docks at Singapore and the Johore causeway in the Federated Malay States, Colombo harbour, wharfage at Kilindini in East Africa, entrance works and wharfage at Lagos, as well as harbour works on the Gold Coast, at Sierra Leone, and Gambia.

He was closely associated with the work of the Institution of Civil Engineers. In 1928 he became a member of Council and was later made Vice-President, afterwards becoming the senior Vice-President of the Institution. He was made an honorary member of the Institution in 1940.

Mr. Wilson was intimately associated with numerous other civil engineering undertakings, among which may be mentioned the Fishguard harbours for the Great Western Railway Company and the Aire and Calder navigation scheme. He advised the Admiralty on the design and construction of the Singapore naval base. In New Zealand he advised the Lyttelton and Gisbourne Harbour Boards and was associated with the Whangpu conservancy scheme, and work for the Mersey Docks and Harbour Board.

In connection with the European Commission for the Danube, in 1921 Mr Wilson was a member of the consultative committee of engineers convoked by the Commission. He was also a member of the Sea Action Committee and subsequently became the Chairman of that body. From 1929 until 1933 he was in charge, under the direction of a Departmental Committee, of the technical investigation into the scheme for the generation of electric power from the tides in the Severn estuary, the report on which was, we may recall, issued in 1933. For many years he took a leading part in the work of the British Standards Association, now the B.S.I., and for several years from 1923 until 1933 was its Chairman.

With Maurice Wilson's technical abilities were allied a charm and gentleness of manner which endeared him to those who knew him well and attracted those who knew him only as a casual acquaintance.

The Physical Society's Exhibition

No. I

THE exhibitions of scientific instruments, under the auspices of the Physical Society, which before the war used to be held annually early in the New Year, have been resumed this year, with the thirtieth exhibition of the series. Following pre-war practice, the exhibition was held at the Imperial College of Science and Technology, South Kensington, S.W.7, on Tuesday, Wednesday, and Thursday of this week. Leading manufacturers exhibited their latest products in the trade section and various research laboratories contributed to the interest of the research and educational section. In what follows we start briefly to describe some of the more notable exhibits.

Amongst several instruments on the stand of Marconi Instruments, Ltd., we have selected for description an electrostatic viewing unit, illustrated in Fig. 1. The unit, designated type "T.F.816," is an A.C.-operated instrument primarily designed for the investigation of the performance of pulsed R.F. communications equipment and incorporates a novel system—based on a design due to the R.A.E.—whereby the time base is triggered by the signal pulse itself and is not dependent on any auxiliary synchronisation. The instrument may best be described as electrically comprising three main sections :—A cathode ray tube with automatically triggered high-speed time base to which D.C. pulses may be applied and directly viewed without synchronisation; a crystal rectifier with valve amplifier which may be switched into circuit to enable R.F. pulses to be similarly viewed; and a squarewave and pulse generator for modulating the apparatus under test, if required.

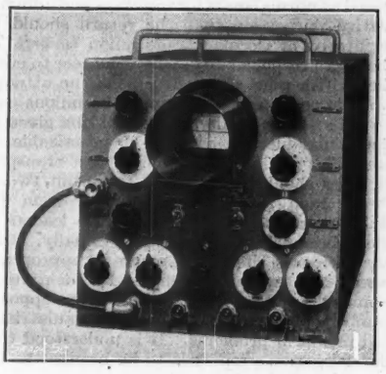


FIG. 1—ELECTROSTATIC VIEWING UNIT

The important feature of the equipment lies in the arrangement of the time base and its non-dependence on separate synchronisation—it is normally directly triggered by the D.C. pulse to be viewed unless a synchronising signal is desired for any specific reason. The principle of operation is based on the fact that all pulses require a finite time to rise; by the use of sufficient amplification, therefore, the initial portion of the rise can be utilised to trigger a single-cycle self-restoring time base generator. With this system the pulse under investigation may be viewed without the need for delay networks and without appreciable loss.

Provision is made, however, for the employment of a synchronising signal if required, as, for example, when checking the delay occurring between the application of a modulating pulse and the production of the corresponding signal pulse, for which purpose either the internal generator or an external source may be employed.

A variety of time-base velocities can be selected at will and a calibrated H-shift is included for pulse-width and delay measurements. For the checking of the calibration of the H-shift control, a series of ringing circuits is provided. All normal controls—brilliance, focus, &c.—are also provided. The input from the R.F. test inlet is taken *via* a crystal rectifier and amplifier to enable R.F. pulses to be viewed in a similar manner. The gain of the amplifier is variable and is sufficient to permit the investigation of R.F. pulses of relatively low amplitude. The internal generator, which produces externally available D.C. pulses of either polarity, provides either squarewave or pulse outputs, both recurrence frequency and pulse-width being variable.

The complete assembly takes the form of a compact single unit of rectangular shape, the necessary power packs being included internally.

Included in the apparatus shown by the Cambridge Instrument Company, Ltd., was an electric micrometer strip thickness gauge, which has been designed for use on steel rolling mills and for checking metals having a low compressibility factor. With it variations in thickness of 0·0001in. can be determined on material up to ½in. thick. The gauge has two steel roller jaws, one fixed and the other floating. As strip or sheet leaves the mill it passes between the jaws of the gauge and thickness variations cause movement of the floating jaw. These movements are communicated to an armature and produce corresponding variations in electric current, which are registered on indicators either of the pointer or the illuminated moving scale type, or on a recorder having a continuous chart. Alarm outfits may be supplied with these gauges to draw prompt attention to variations in thickness beyond a certain range.

A new Cambridge quick-acting recorder has a continuously self-balancing pen which has a high-response speed. It is adaptable for recording variations in magnitude of phenomena which may be translated into terms of voltage or resistance. The record is drawn on a continuous chart, 180 mm. wide, driven at speeds up to 2½in. per minute by a synchronous motor. For a recording potentiometer, where the full-scale range exceeds 1 mV, the pen will follow a sudden change in the recorded quantity and reach its new position of rest in less than one second without overshoot. The recording pen is coupled to the potentiometer slide wire and to the driven members of two electro-magnetic clutches, the driving members of which are rotated continuously in opposite directions. The clutch windings form the output load of a balance detector and amplifier and are energised differentially depending on the magnitude and sense of the unbalance in the potentiometer system. The resulting motion is in such a direction as to restore balance and bring the recorder pen to the position corresponding to the quantity being recorded.

An apparatus the company designed primarily for testing the porosity of parachute fabrics can be applied to a number of other materials. It comprises a testing chamber having an effective area of 10 square inches, a differential pressure dial gauge, and a Chattock tilting micromanometer, all mounted together on a base board, together with an electrically driven suction air pump. In use, the sample of fabric to be tested is clamped over the open end of the testing chamber, and air is drawn through the sample by means of the pump, the rate of flow being stabilised by a valve at exactly 1 cubic foot per minute, indicated on the differential gauge by a reading of 1·0in. water. The pressure difference across the sample is determined by the micromanometer, which is capable of reading to 0·0001in. water, giving an accurate measure of the porosity. Air flow through the 10 square inches of the sample at the specified pressure is equal to 14·4 cubic feet per minute per square foot of fabric. One turn of the micromanometer dial represents a pressure of 0·144 lb. per square foot. Thus, if a reading is 1·78, then the pressure required to produce a flow of 14·4 cubic feet of air per minute per square foot through the sample is $0{\cdot}144 \times 1{\cdot}78$ lb. per square foot.

(To be continued)

Industrial and Labour Notes

Labour for the Ironfoundries

It has been realised for some months past that an acute shortage of workers in ironfoundries is seriously delaying the production of light castings needed in connection with housing programmes, and also of engineering castings required in the process of industrial reconversion. A committee on special methods of recruitment to ironfoundries was recently set up by the Minister of Labour and National Service to consider how best this urgent demand for skilled and unskilled labour could be met. Acting on a recommendation of this committee, the Ministry of Labour has now announced that young men who become redundant in non-ferrous metal and steel foundries or who can be released from such work, will be directed to work in ironfoundries, subject to the usual right of appeal. Such direction will justify deferment of call-up for military service. The number of men needed for the ironfoundries cannot be estimated exactly, but is said by the Ministry of Labour to be of the order of 35,000, of whom 15,000 are wanted for the production of builders' castings. The labour force of the foundries fell considerably during the war, chiefly as a result of measures of concentration and call-up, and every effort is now being made to secure the return of foundry operatives from other industries and from the Services, but it is clear that a labour force of the size required cannot be got together in a reasonable time by the normal means of labour supply. In these circumstances, the Ministry of Labour and National Service enlisted the help of both sides of the industry, and the committee which was appointed comprised representatives of the Joint Iron Council, the Engineering and Allied Employers' National Federation, the National Union of Foundry Workers, the Iron, Steel, and Metal Dressers' Trade Society, and the Ironfounding Workers' Association. Amongst other matters, the committee has explored the possibility of importing foreign labour from France and Belgium, but this suggestion could not be made effective, as there is a distinct shortage of labour in the same field in both of those countries.

Double Day Shifts and a Forty-Hour Week

Some comments on the question of double-day shift working, which is at present the subject of a Government inquiry, are made in the December issue of *The A.E.U. Monthly Journal*. The Trades Union Congress has already undertaken to submit written evidence to the Government committee, and unions have now been invited by the T.U.C. to consider the evidence which its General Council proposes to put forward. The Executive Council of the A.E.U. is therefore giving careful consideration to the double-day shift system in the light of the T.U.C. statement. It is suggested that the question of developing the shift system arises mainly out of the difficulties of the transition to peacetime production, for there is a strong demand for those industries concerned with the re-equipment, modernisation, and mechanisation of our productive system to attain maximum output. Mechanisation of industry, moreover, where modern and costly machinery is installed, requires continuous operation of such machinery in view of the heavy load of overheads involved, and as a *prima facie* case can be made out against the traditional working day of industry, the A.E.U. says that it is prepared to consider it with an open mind. Another reason why the matter should be considered with an open mind, the A.E.U. states, is because modifications of the shift system seem to be implied in the trade union policy of the standard working week of forty hours. The secretary of the T.U.C. has recently expressed the view that the forty-hour week should be enacted soon, as a general legal standard for all industry, but that its application could be made in two or more stages and industry by industry. The A.E.U. considers that there is something to be said for this suggestion of an Act empowering the Government and industry to work out a plan for the introduction of the forty-hour week by stages, and with sufficient flexibility to adapt the principle to the varying needs of different branches of industry.

The T.U.C. and German Trade Unions

At its December meeting the General Council of the Trades Union Congress received the report of three of its members—Messrs. W. Lawther, H. Bullock, and J. Tanner—on their recent visit to the British zone in Germany for the purpose of studying trade union conditions there. The report is chiefly concerned with the general desire of German trade unionists to form one all-inclusive union which could be divided into specialised industrial groups. The delegation has already indicated that it supported the view of the British Control Commission that the formation of a single union would be a mistake, and the General Council approved the delegation's recommendations which are designed to counteract this desire for an all-inclusive trade union. Suggestions made in the delegation's report are that German unions in a large industrial centre should be permitted to extend their activities into the adjoining areas; that a trade union journal should be instituted, to be produced, under censorship, by German trade unionists for all areas in the British zone; that available trade union buildings should be leased at normal rents for meetings and administrative purposes; that the return should be facilitated of German trade union *émigrés*, on their own responsibility, who volunteer to enter the British zone, on condition that no attempt is made to impose them upon the unions concerned; that consideration should be given to the reintroduction, as soon as practicable, of pre-Hitler working conditions; that transport facilities should be provided to permit two or three trade union representatives from the Ruhr to attend meetings with the leaders of the Hamburg unions; and, finally, that arrangements should be made in appropriate cases—miners, for example—for delegations from this country to meet their opposite numbers in Germany to discuss organisational and technical problems. It is understood that the delegation's report is to be brought to the attention of the Government.

The Combined Boards

The work of the Combined Production and Resources Board and the Combined Raw Materials Board came to an end on December 31st. In paying tribute to the achievements of the Boards in the full and equitable utilisation of resources for the effective prosecution of the war, the Prime Ministers of Great Britain and Canada and the President of the United States made reference to a few commodities which call for continued attention as they are in global short supply in relation to the needs of consuming countries. Cotton textiles, tin, rubber, and hides and leather are cited in particular, and it is therefore proposed that the committees which are concerned with these commodities and which were set up under the Boards shall be continued for such period as is rendered necessary by the shortage of supply in relation to needs. It is proposed that in all cases representation on these committees shall be on an appropriate international basis having regard to their independent status following the dissolution of the Boards. It may be recalled that in most cases committee membership already includes countries having a major interest in the problems involved. With regard to coal, there exists an organisation in respect of Europe, but special considerations make it desirable that for the time being the coal committees, set up under the Boards in Washington and London, continue in their existing forms.

Iron and Steel Prices

The Minister of Supply has made the Control of Iron and Steel (No. 46) Order, 1945 (which consolidates all previously subsisting Orders, except the Scrap Orders and the No. 44 Order relating to the use of tinplates in the production of certain articles) and the Control of Bolts, Nuts, &c. (No. 9), Order, 1945. The main purpose of both these Orders, which came into operation on December 31st, is to provide for higher maximum prices in relation to current costs of production. Prices of iron and steel in general have remained stabilised since 1940, in spite of higher costs, particularly of coal and imported iron ore, the latter owing mainly to increased freights. The special arrangements made with the iron and steel industry to maintain 1940 prices are now generally discontinued, but limited assistance in the case of freights on imported ores is being continued for the present. The basis price of pig iron has been increased by £1 a ton, and, in general, the price increase on the main steel products is about 5 per cent., though on more highly finished steel products the increases are in some cases greater and in others less than this figure. It has been found possible, however, to reduce the price of motor body sheets made on the strip mills by about £2 a ton. Amendments in price control have been made as follows:—Iron ore and cinder and scale are freed from price control; where material is produced to meet unusual requirements, the Minister of Supply may authorise an addition to the maximum price, the maximum prices formerly applying to all sales and purchases, except where delivery was made outside the United Kingdom or on board a ship for exportation outside the United Kingdom. These exceptions have now been widened to include sales within the United Kingdom, so long as the material is ultimately exported without having been subjected to any use or treatment. Other amendments are that electrical stampings have been freed from all control; all restrictions on the use of cinder and scale have been removed; and restrictions on the acquisition and disposal for export of springs and certain wire products have also been removed. The Related Schedules lodged under the new Orders—Nos. 1 to 115 in the case of No. 46 Order and Nos. 1 to 43 in the case of No. 9 Order—may be inspected at the offices of the Iron and Steel Control, Steel House, Tothill Street, London, S.W.1.

Research Facilities

Two items of news relating to the extension of research facilities have been announced in the last week or so. The first concerns the formation of an association known as Alar, Ltd., 6, Old Jewry, London, E.C.2, which is a post-war result of the collaboration of a group of light metal manufacturers, originated during the war, with the idea of pooling technical information in the national interest. By means of this newly constituted organisation, the co-operative efforts of the technical staffs of these manufacturers are now being applied to the peacetime requirements of industry. It is stated that Alar's purpose is first, to ensure that the present high standard of secondary aluminium alloys is maintained, and secondly, to promote the uses of these alloys by bringing about a wider appreciation of their properties. Alar, Ltd., is solely a technical organisation, and its research programme, which includes the development of new alloys, is to be carried out in close collaboration with other technical and research associations. One feature of its policy is the issuing of publications drawing the attention of existing and potential users to up-to-date information on the properties and applications of aluminium alloys. The other item of research news is the formation by Standard Telephones and Cables, Ltd., of a central laboratory organisation to undertake long-term research and development in the telecommunication, electronics, and allied fields. This new organisation will be known as Standard Telecommunication Laboratories, Ltd., and will be housed at Progress Way, Great Cambridge Road, Enfield, pending the erection of suitable permanent premises.

French Engineering News

(From Our French Correspondent)

PARIS, Friday.

THE devaluation of the franc may make itself felt in the heavy industries in the future, but not for some time yet. While French luxury industries will be able to export, the engineering industry is suffering from an acute lack of fuel, and the consequences of the present electricity shortage are proving serious. The Government has closed all non-priority factories three days a week, so that the average working week is now twenty-seven to thirty hours instead of forty to forty-eight. Industry has to make up wages and the drain on financial resources, therefore, is very considerable. Naturally, the factories will be reimbursed by the Government, but only after considerable delay. Production has slumped and orders, few as they are (industry has to limit orders to raw materials available), take twice as long to complete. This state of affairs is likely to continue until the spring, when the snows melt and the hydro-electric plants again begin to produce.

* * *

The Government has set up a Production Council, under the presidency of Monsieur Jean Monnet, who, at the beginning of the war, made combined Anglo-French purchases in the United States, and after the fall of France worked on the British Purchasing Board in America. M. Monnet will have the task of combing over French industry and carrying out a programme of modernisation. He will be assisted by all Ministers concerned with production and economics, and also by factory committees comprising the employer's representative, a trade union representative, and a Government representative. The committee's job will be to keep an eye on production methods and make such suggestions as will be likely to increase production. Monsieur Monnet's council will handle the purchase of machine tools and such other equipment necessary to increase French production.

* * *

Monsieur Dumas, director of l'Aluminium Française, talking about non-ferrous metals and aluminium in particular, before the Society of French Civil Engineers, recently revealed that a new aluminium plant with an annual capacity of 30,000 tons is being constructed at Issoire. According to Monsieur Dumas, this plant, which will be ready in 1947, will leave nothing to be desired, and will be on a level with any of the best American aluminium plants.

* * *

Coal production in France for the week ended December 15th, shows an increase to 905,000 tons, as against 724,000 tons the previous week. Daily coal production was 150,798 tons, against 144,896 tons. The rise is due to an increase in the number of working days. Stocks at the end of the week stood at 149,000 tons, against 131,000 tons. Imports amounted to 203,431 tons, against 187,873 tons. French coal production now stands at 99 per cent. of 1938 figures. Iron and steel production also shows small increases, but the figures are highly unsatisfactory when compared with 1938. In that year France had 107 furnaces and produced an average of 500,000 tons of pig and 515,000 tons of steel every month. The number of furnaces now working is twenty-five, against eighteen in August, and production stands at 169,000 tons of pig in November and 229,000 tons of steel for the same month, against 109,000 tons of pig and 139,000 tons of steel in August.

* * *

Latest railway reconstructions include the viaduct at Beaugency. Its repair will enable the S.N.C.F. to eliminate one of the three single-track sections still in use on the Paris-Bordeaux line. During the war masonry bridges across the two arms of the Loire on the Nantes-Bordeaux line were seriously damaged. On December 15th temporary repairs were completed, permitting normal railway traffic to run between Nantes and La Rochelle.

Notes and Memoranda

Rail and Road

G.W.R. RESTAURANT CARS.—On Monday, December 31st, the Great Western Railway restored its restaurant car facilities on fourteen weekday and seven Sunday trains between Paddington and the West of England, South Wales, and the Midlands. The restaurant cars used on the Cornish Riviera Limited, are of entirely new design, having a new system of lighting and ventilation, etched plate glass draught screens, and tub-type swivel chairs. Empire woods with carpets and curtains to tone are used in the interior scheme of decoration.

EXPORT OF CARS.—In connection with the de-control of sales of new motor vehicles in the home market, the Board of Trade has had discussions with the Society of Motor Manufacturers and Traders regarding the export of cars. The chief makers of private and commercial vehicles are anxious to build up their export trade as quickly as possible, and the Society has undertaken on behalf of its principal members that during the first six months of 1946 half the output of new cars and a third of the output of commercial vehicles will be devoted to export. The matter will be further discussed with the Society before the middle of next year. Arrangements will shortly be made to free the export of commercial vehicles from control by licence; private cars are already free from export control.

NEW L.M.S. SERVICES.—The London, Midland and Scottish Railway has introduced new and improved services between London and Liverpool and Manchester. Accelerations have also been effected with the boat trains run in connection with the L.M.S. Heysham and Belfast and Holyhead and Kingstown steamer services. New trains include those leaving Manchester (London Road) at 4.05 p.m., arriving at Euston at 8.15 p.m.; Liverpool (Lime Street) at 4.05 p.m., arriving at Euston at 8.35 p.m.; Euston at 1.30 p.m., arriving at Liverpool at 5.35 p.m.; the 12 noon train from Euston to Manchester, which now runs each weekday (a restaurant car service is provided on these trains); the 3 p.m. boat train, Euston to Heysham, leaves at 3.35 p.m. without alteration to the arrival time; and in the reverse direction the 8.18 a.m. boat train has been retimed to leave Heysham at 6.25 a.m. (Mondays excepted), arriving at Euston at 11.55 a.m. The Holyhead to Kingstown steamer leaves at 3.30 p.m. instead of 4 p.m., giving a correspondingly earlier arrival at Kingstown, whilst the steamer leaving Kingstown departs at 9.50 a.m. (Eire time), arriving at Holyhead correspondingly later.

Air and Water

COLOGNE'S AIRFIELDS.—The Control Commission for Germany (British Element) has recently stated that the largest civilian airport in the west of Germany, the Lufthansa, at Butzweiler Hof, near Cologne, is to be turned into arable land. This means that all Cologne's aerodromes are now being used for peaceful purposes.

THE LIFEBOAT SERVICE IN 1945.—During 1945 the lifeboats of the Royal National Lifeboat Institution rescued 537 lives. In the first four months of the year, up to the end of the war in Europe, they rescued 223, and in the eight months of peace 314, so that they rescued 55 a month in the four months of war and have rescued 39 lives a month since then. In spite of many difficulties, the Institution has been able to lay down eight new lifeboats of the eighty which it intends to build to make up for the losses and delays of the war.

BERMUDA CIVIL AVIATION TALKS.—The Ministry of Civil Aviation announces that a party, headed by Mr. W. C. G. Cribbett, C.M.G., Deputy Director-General of Civil Aviation, has left this country for Bermuda in order to engage in conversations with representatives of Canada and Newfoundland on civil aviation matters which concern the three Governments. The subjects to be discussed include the changeover of airfields in Newfoundland and Labrador from military to civil control, and Canadian and British air services across the North Atlantic and elsewhere.

CANADA'S WATER RESOURCES.—The Dominion Water and Power Bureau, Surveys and Engineering Branch of the Department of Mines and Resources of Canada, has published volume 88 of the Water Resources Papers, which deal with the surface water supply of Canada. This number contains the results of investigations by the Dominion Hydrometric Survey in the provinces of Alberta, Saskatchewan, Manitoba, the North-West Territories, and parts of British Columbia and Western Ontario for the climatic years October 1st, 1939, to September 30th, 1941. The report contains a short explanation of the organisation and scope of the work and 339 pages of stream flow data for rivers and streams within the area mentioned, together with meteorological data, including evaporation, for stations in Ontario, Manitoba, and Saskatchewan.

THE CHANNEL TUNNEL.—The Minister of War Transport was recently asked in the House of Commons whether all security objections to a Channel Tunnel had now been removed, and if he would consider plans to construct a tunnel for road and rail traffic as soon as labour and materials were available. The Minister's reply stated that, apart from any other considerations, including the development of civil aviation, there were many urgent problems of improvement and development of transport in this country to which priority would have to be given before this particular and inevitably costly project was considered.

Miscellanea

BRITAIN'S COAL OUTPUT.—The Ministry of Fuel and Power has announced that the weekly coal output in the month of November was 3,593,700 tons, which was 26,300 tons a week more than in October, but 150,200 tons a week less than in November, 1944. Although the number of wage-earners on colliery books was down in November, the "effective employment" was greater. Absenteeism from all causes was slightly lower than in October, but there was a small increase in voluntary absenteeism. The production of open-cast coal amounted to 139,100 tons a week in November, compared with 174,500 tons a week in October and 166,600 tons a week in November, 1944.

POST-ADVANCED ENGINEERING COURSES.—The Regional Advisory Council for Technical and Other Forms of Further Education in Manchester and District has lately issued a booklet giving particulars of post-advanced lectures in electrical and mechanical engineering, which are taking place during the session 1945–46. Details are given concerning evening courses in specialised branches of engineering, which are being provided on the recommendation of an advisory committee set up by the Council, and information is also included on post-advanced courses in engineering available in the technical colleges of the region. The hon. secretary to the Regional Advisory Council is Mr. W. O. Lester Smith, M.A., Education Offices, Deansgate, Manchester, 3.

THE LATE MR. EDGAR PAM.—We regret to record the death on December 20th of Mr. Edgar Pam, a director of the Mond Nickel Company, Ltd., and President of the Institution of Mining and Metallurgy. Mr. Pam was a mining engineer by profession and received his early training at the Royal School of Mines. He was engaged for many years with the Central Mining and Investment Corporation, Ltd., in South Africa, and eventually became general manager of Modderfontein East, Ltd. He joined the Mond Nickel Company in 1928 as consulting mining engineer, and, after the merger with the International Nickel Company he was appointed assistant to the delegate director, and subsequently deputy delegate director. In the spring of 1945 he became a member of the Mond board. He was closely concerned with the company's operations in Northern Finland down to the time of the outbreak of war there.

ELECTRICITY IN ICELAND.—Electricity, in all its applications, will soon be available to the 6000 inhabitants of Vestmanna, a group of islands 30 miles south of Iceland. The community practically lives on its fishing industry. Its decision to substitute a full A.C. supply for the inadequate D.C. service previously in use is one of the indications of its modern outlook. British Oil Engines (Export), Ltd., of London, are the main contractors for the power station equipment, and the agents in Iceland responsible for the installation are O. H. Helgason and Co., whose director, Mr. Goodmundson, is at present in Great Britain on a tour of inspection of the manufacturing methods of the power plant companies. The two engines comprising the power plant are by Mirrlees, Bickerton and Day, Ltd., of Stockport, and the generators, made by the Brush Electrical Engineering Company, Ltd., of Loughborough, generate A.C. at 6·6 kV. In Vestmanna, all children reaching the age of twelve have to be able to swim two lengths of the swimming baths. Waste heat recovery equipment is fitted to the plant referred to above to heat the water for the baths.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chartered Surveyors' Institution

Monday, Jan. 7th.—12, Great George Street, Westminster, S.W.1. "Town Planning Interim Development and Repair of War Damage," H. G. May. 5.30 p.m.

Derby Society of Engineers

Monday, Jan. 14th.—School of Arts, Green Lane, Derby. "Town Planning," M. L. Francis. 7 p.m.

Gauge and Toolmakers' Exhibition

Monday to Friday, Jan. 7th to 18th.—New Hall, Vincent Square, London, S.W.1. 10 a.m. to 8 p.m. daily.

Illuminating Engineering Society

Tuesday, Jan. 8th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "B.S.I. Specification for Street Lighting," J. W. T. Walsh, F. C. Smith, and J. M. Waldram. 6 p.m.

Institute of British Foundrymen

Saturday, Jan. 5th.—LANCASHIRE BRANCH: The Engineers' Club, Albert Square, Manchester. "The Production and Treatment of Alloy Cast Irons," G. W. Nicholls. 3 p.m.

Monday, Jan. 7th.—SHEFFIELD BRANCH: Royal Victoria Hotel, Sheffield. "Closer Co-operation Between the Foundry and Pattern Shop," W. C. Meredith and H. S. W. Brittain. 7 p.m.

Tuesday, Jan. 8th.—BURNLEY SECTION: Municipal College, Ormerod Road, Burnley. "Improved Core Assembly Methods," E. Binns. 7.30 p.m.

Wednesday, Jan. 9th.—LONDON BRANCH: Charing Cross Hotel, Strand, W.C.2. Discussion on "Patent Laws as Affecting the Metallurgical Industry." 7.30 p.m.

Saturday, Jan. 12th.—SCOTTISH BRANCH: Royal Technical College, George Street, Glasgow. "Design as Applied to Foundry Practice," D. C. Hagen. 3 p.m.—WEST RIDING BRANCH: Technical College, Bradford. "Alloy Cast Irons: Their Production, Treatment, and Application," G. W. Nicholls. 6.30 p.m.

Institute of Marine Engineers

Tuesday, Jan. 8th.—85, The Minories, E.C.3. "Fundamentals of Ship Propulsion," F. H. Todd. 5.30 p.m.

Institute of Transport

Monday, Jan. 14th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Allied Transport on the Continent—D Day to V Day," Major-General C. S. Napier. 5.30 p.m.

Institute of Welding

Thursday, Jan. 10th.—S. LONDON BRANCH: County Technical College, Stoke Park, Guildford. "The Application of Welding to Agricultural Machinery," G. C. Bainbridge. 7.30 p.m.

Friday, Jan. 11th.—BIRMINGHAM BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "Developments in the Technique and Use of Resistance Welding," R. W. Ayres. 7 p.m.

Institution of Automobile Engineers

Tuesday, Jan. 8th.—COVENTRY BRANCH: Geisha Café, Hertford Street, Coventry. "Engine Proportions, with Special Reference to Stroke/Bore Ratio," A. Mitchell. 7 p.m.—LUTON GRADUATES: George Hotel, Luton. "The Painting of Automobiles," F. W. Summerland. 7.15 p.m.

Tuesday, Jan. 15th.—LUTON BRANCH: George Hotel, Luton. "The Trend in American Passenger Cars," M. Olley. 7.30 p.m.

Institution of Chemical Engineers

Friday, Jan. 11th.—N.W. BRANCH: Town Hall, Manchester. "Chemical Engineering Research," C. J. T Cronshaw. 2.30 p.m.

Institution of Civil Engineers

Tuesday, Jan. 8th.—ROAD SECTION: Great George Street, Westminster, S.W.1. "Some Economic Aspects of Modern Earth-Moving Equipment," C. T. Mitchell. 5.30 p.m.—NEWCASTLE ASSOC.: Neville Hall, Westgate Road, Newcastle-on-Tyne. "The Lay-Out and Construction of Roads," L. W. Floyd. 6.15 p.m.

Tuesday, Jan. 15th.—NEWCASTLE ASSOC.: Mining Institute, Westgate Road, Newcastle-on-Tyne. "The Water Resources of North-East England," Professor H. G. A. Hickling. 6.15 p.m.—STRUCTURAL AND BUILDING SECTION: Great George Street, Westminster, S.W.1. "Shop and Site Welding," A. Ramsay Moon. 5.30 p.m.

Institution of Electrical Engineers

Monday, Jan. 7th.—S. MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Electrical Engineering Industry in After-War Economy," G. L. E. Metz. 6 p.m.—LONDON STUDENTS: Savoy Place, Victoria Embankment, W.C.2. "Electrical Measurement of Temperature," R. J. Redding. 7 p.m.—MERSEY CENTRE: Royal Institution, Colquitt Street, Liverpool. "Operational Control of Electricity Supply Systems," W. Kidd and E. M. S. McWhirter. 6 p.m.

Wednesday, Jan. 9th.—SCOTTISH CENTRE: Royal Technical College, George Street, Glasgow. "Frequency Modulation," K. R. Sturley. 6.15 p.m.—TRANSMISSION SECTION: Savoy Place, Victoria Embankment, W.C.2. "Steel Tower Economics," P. J. Ryle. 5.30 p.m.

Thursday, Jan. 10th.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. "The Control of Electrical Installation Work," W. R. Watson. 5.30 p.m.

Monday, Jan. 14th.—Savoy Place, Victoria Embankment, W.C.2. "Country Road Lighting," C. R. Bicknell. 5.30 p.m.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-on-Tyne. "Street Lighting," E. C. Lennox. 6.15 p.m.

Institution of Engineers-in-Charge

Monday, Jan. 7th.—St. Bride's Institute, Bride Lane, Fleet Street, E.C.4. "Ventilation," L. Norton, 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Jan. 15th.—39, Elmbank Crescent, Glasgow C.2. "Fuel and Power: Scotland's Present-Day Problems and Future Prospects," J. Edward. 6.30 p.m.

Institution of Heating and Ventilating Engineers

Wednesday, Jan. 9th.—72, Victoria Street, S.W.1. "A Factory in a Railway Tunnel," S. C. Mount. (Time not stated).

Institution of Mechanical Engineers

Monday, Jan. 7th.—N.E. BRANCH: Mining Institute, Neville Hall, Newcastle-on-Tyne. "Power Stations of the Future," G. H. Martin. 6 p.m.

Tuesday, Jan. 8th.—S. WALES BRANCH: S. Wales Institute of Engineers, Cardiff. "The Scientist in Wartime," Sir Edward Appleton. 6 p.m.

Saturday, Jan. 12th.—LONDON GRADUATES: Storey's Gate, Westminster, S.W.1. "Fuel Injection System on Diesel Engines," S. Sarwal. 3.30 p.m.—N.E. GRADUATES: Newcastle Gas Company, Grainger Street, Newcastle-on-Tyne. "Blast-Furnaces," A. J. Suggit. 2.30 p.m.

Friday, Jan. 18th.—Storey's Gate, Westminster, S.W.1. "The Development of the La Mont Boiler in Great Britain," G. A. Plummer; and "Operating Experience with La Mont Boilers, with Special Reference to Feed Water Problems," G. A. J. Begg, W. M. Hebblethwaite, and G. Cooke. 5.30 p.m.

Institution of Production Engineers

Saturday, Jan. 5th.—N.E. GRADUATES: Gas Company, St. John Street, Newcastle-on-Tyne. Social evening. 6.30 p.m.

Monday, Jan. 7th.—COVENTRY GRADUATES: Technical College, Coventry. "Designing for Efficient Production," R. R. Brittain. 7 p.m.—YORKSHIRE SECTION: Hotel Metropole, Leeds. "Electronics in Production Engineering," E. W. Forster. 7 p.m.

Tuesday, Jan. 8th.—LUTON AND DISTRICT SECTION: Town Hall, Luton. Film on "Grinding." 7 p.m.—BIRMINGHAM GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. Discussion. 7 p.m.

Wednesday, Jan. 9th.—MANCHESTER GRADUATES: College of Technology, Manchester. "Modern Foundry Practice," J. W. Gardom. 7.15 p.m.

Friday, Jan. 11th.—LEICESTER BRANCH: College of Technology, Leicester. "Time Study," W. T. Laxton Roberts. 7 p.m.

Saturday, Jan. 12th.—YORKSHIRE GRADUATES: Great Northern Hotel, Leeds. Short papers by Graduates and Students. 2.30 p.m.

Tuesday, Jan. 15th.—WOLVERHAMPTON GRADUATES: Technical College, Walsall. "Application of Hydraulic Power to Machine Tools," D. W. Goodreid. 6.30 p.m.

Iron and Steel Institute

Wednesday, Jan. 9th.—Rational Hall, Ebbw Vale. Refractories—the Limiting Factor on Open-Hearth Design," J. H. Chesters. 6.45 p.m.

Junior Institution of Engineers

Saturday, Jan. 5th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. "Ideas in Engineering," A. N. Haworth. 2.30 p.m.

Friday, Jan. 11th.—39, Victoria Street, S.W.1. "Magnetic Compasses in Ships, Aircraft, and Armoured Vehicles," D. A. Turner and A. Hine. 6.30 p.m.—WESTERN GROUP: Merchant Venturers' Technical College, Unity Street, Bristol. Discussion evening. 7.30 p.m.

Manchester Geographical and Mining Society

Tuesday, Jan. 8th.—Engineers' Club, Albert Square, Manchester. "Seven Years' Experience of Skip Winding," E. Hart. 3 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Jan. 11th.—Mining Institute, Westgate Road, Newcastle-on-Tyne. "Science and Craftsmanship in the Engineering and Shipbuilding Industries," J. W. Stephenson. 6 p.m.

West of Scotland Iron and Steel Institute

Friday, Jan. 11th.—39, Elmbank Crescent, Glasgow, C.2. "Metallurgical Factors Affecting Corrosion and Protection," K. G. Lewis. 6.30 p.m.

Women's Engineering Society

Thursday, Jan. 10th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. "Ships' Engines," G. W. G. Canter. 6.30 p.m.

Personal and Business

MR. E. J. FOX has resigned from the board of Crompton Parkinson, Ltd.

MR. NOEL F. NEWSOME has been appointed Director of Recruitment in the Ministry of Fuel and Power.

GASTON E. MARBAIX, Ltd., has changed its address to Devonshire House, Battersea Square, S.W.11 (telephone, Battersea 8640).

SIR HARRY TRUSTED has been appointed secretary of the Association of Consulting Engineers (Incorporated), in the place of Mr. E. W. Baynes, who has retired.

ALBRIGHT AND WILSON, Ltd., announce that their water treatment department has been moved from Oldbury to 49, Park Lane, London, W.1 (telephone, Grosvenor 1311).

THE EUROPEAN CENTRAL INLAND TRANSPORT ORGANISATON announces that its headquarters are now at 40, Grosvenor Square, London, W.1 (telephone, Mayfair 9070).

MR. FRED CLEMENTS has resigned his position as chairman and managing director of the Park Gate Iron and Steel Company, Ltd. He retains a seat on the board as technical and consulting director. Mr. Ashley S. Ward has been appointed chairman and managing director of the company.

SIR P. MALCOLM STEWART has resigned the chairmanship and managing directorship of Associated Portland Cement Manufacturers, Ltd., and British Portland Cement Manufacturers, Ltd. He will act as advisory director, and is to be designated president of each company. The respective boards have appointed Mr. G. Foster Earle as chairman.

THE TUBE INVESTMENTS GROUP announces the registration in the Argentine of a new subsidiary company, Tubos Britanicos (Argentina) S.R., Ltda., to provide a technical advisory service for South American purchasers of British steel tubes. The resident British director of the new company, Mr. R. D. Young, was formerly production manager of the Desford works of Tube Products, Ltd.

THE MINISTER OF SUPPLY AND AIRCRAFT PRODUCTION has agreed to release the following regional controllers:—Mr. H. C. M. Austen, South-Western Region; Major V. W. Eyre, London and S.E. Region; Mr. C. W. Haynes, Midland Region; Lieut.-Colonel H. Gordon Luhrs, London and S.E. Region; Mr. C. A. Oakley, Scottish Region; Mr. V. Proctor and Mr. F. A. M. Vincent, East and West Ridings.

MR. H. BOCLER has retired from his position as naval architect to Swan, Hunter and Wigham Richardson, Ltd., Wallsend Shipyard, but is remaining on the staff in a consultative capacity. He has been at Wallsend Shipyard since 1898, and has acted as chief naval architect since 1929. Mr. W. Buckie has been appointed technical manager and chief draughtsman, and Mr. N. Carter is to take up the position of naval architect.

MR. F. H. ROLT, B.Sc., A.C.G.I., M.I. Mech. E. has been selected for the appointment of Superintendent of the Metrology Division of the National Physical Laboratory, with effect from April 1st, 1946, on the retirement from that post of Mr. J. E. Sears, M.A., M.I. Mech. E. Mr. Rolt has been a member of the staff of the N.P.L. since 1912, but during the war his services have been lent to the Ministry of Supply. Mr. A. Fage, A.R.C.S., D.I.C., F.R.Ae.S., F.R.S., has been appointed Superintendent of the Aerodynamics Division of the National Physical Laboratory, in succession to Mr. E. F. Relf, A.R.C.S., F.R.Ae.S., F.R.S., who is taking up the post of Principal of the College of Aeronautics. Mr. Fage has been a member of the staff of the N.P.L. since 1914.

Calendars and Diaries

WE acknowledge the receipt of calendars for 1946 from the undermentioned firms:—

Ashwell and Nesbit, Ltd., Leicester.

Ruston and Hornsby, Ltd., Lincoln.

Ransomes and Rapier, Ltd., Waterside Works, Ipswich.

Butters Brothers and Co., Ltd., McLellan Street, Glasgow.

A. V. Roe and Co., Ltd., Greengate, Middleton, Manchester.

de Havilland Aircraft Company, Ltd., Hatfield, Herts (diary).

Steel City Supply Company, Ltd., Cambridge Street, Sheffield.

United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10.

Gear Grinding Company, Ltd., Cranmore Boulevard, Shirley, Birmingham.

Escher Wyss Engineering Works, Ltd., Terminal House, 52, Grosvenor Gardens, S.W.1.

Associated Equipment Company, Ltd., Southall, Middlesex (and copy of Motorists' Diary).

A Seven-Day Journal

New Year Honours

IN the first and second New Year Honours Lists the following names appear in addition to those mentioned in last week's Journal note :—Knighthoods have been conferred upon Captain William Arthur Charlton, commodore master of Furness, Withy and Co., Ltd.; Mr. George Perrin Christopher, Director of Commercial Services, the Ministry of War Transport; Mr. John Richard Hobhouse, Regional Shipping Representative for N.W. England for the Ministry of War Transport; Mr. John Robertson Masson, Chief Representative of the Ministry of War Transport in India; Mr. Ralegh Buller Phillpots, chairman of the British Tabulating Machine Company, Ltd.; Lieut.-Colonel Reginald Aneurin Thomas, H.M. Chief Inspector of Explosives, the Home Office; Mr. Theodore Eastway Thomas, lately general manager of the London Passenger Transport Board. In the Navy the K.B.E. has been conferred upon Engineer Rear-Admiral Henry William Wildish (Retd.); and the C.B.E. upon Engineer Rear-Admiral F. H. Buckmaster (Retd.), Engineer Captain A. H. Parry (Retd.), Engineer Captain G. F. Croker (Retd.), and Engineer Captain H. Moy. The O.B.E. is awarded to Mr. R. Baker, Superintendent of Landing Craft, the Admiralty; Mr. J. P. Baxter, Consultant on Atom Bomb Research, the Department of Scientific and Industrial Research; Mr. S. Bower, superintendent of Vickers-Armstrongs, Ltd.; Mr. J. Bradley, Senior Scientific Officer, the National Physical Laboratory; Mr. C. Gordon, Principal Scientific Officer, the Air Ministry; and Mr. C. M. Gough, the Technical Officer; Mr. A. T. Green, director of British Refractories Research, Ltd.; Mr. A. J. Mumford, Staff Engineer, the Engineer-in-Chief Office, G.P.O.; Mr. W. G. Penney, Principal Scientific Officer, Directorate of Atom Bomb Research, the Department of Scientific and Industrial Research; and Mr. W. Perrin, Assistant to the Director; Mr. H. J. Penrose, chief test pilot, Westland Aircraft, Ltd.; Mr. G. Poppe, works manager, Sunbeam Talbot Company, Ltd.; Mr. E. Pugson, principal assistant for carriages and wagons to the chief mechanical engineer of the L.M.S.; Mr. F. H. Rolt, Principal Scientific Officer, the National Physical Laboratory; and Mr. W. Scott, managing director of Jarrow Metal Industries, Ltd. These names are only a few out of the 600 O.B.E.s, 1200 M.B.E.s, and 2000 B.E.M.s in the civil and military divisions.

R.A.F. Transport Command

IN view of comments recently made on the high accident rate in services of R.A.F. Transport Command, official figures have been given in order to prove the safety of the Command's services. It is shown that for every person killed in a crash in 1945, aircraft of the Command flew 8,000,000 miles. The fatality rate on scheduled services was one in 40,000,000 passenger miles, while on trooping flights there was one fatality for every 3,000,000 passenger-miles flown. Taking the five years between 1934 and 1938, British civil air services averaged one fatality in 4,400,000 passenger-miles. Each month the Command carries an average of 125,000 passengers and some 20,000 troops. When making a comparison with a civil air line, it must be borne in mind that the Command has, in the main, had to employ converted bombers, and not specially designed aircraft, for passenger carrying. The civil lines of this country had many years of experience behind them, whereas the organisation of Transport Command has been built up in just over two years, and until the summer of 1945 it had to compete with the operational Commands for priority in both crews and aircraft. During its short existence Command crews have had to fly without many of the ground navigational aids to which civil air line crews were accustomed before the war. The causes of accidents during the past few months have been classified under three main headings—bad basic organisation, inexperienced air crews, and incorrect weather reports. Perhaps the greatest difficulty is the human element. Transport Command has grown at a rate of 100 per cent. a year, and is now operating a world-wide network at a time when it is losing many of its most experienced flying and ground maintenance crews, either by demobilisation or by transfer to civil aviation. There is the closest co-operation between Transport Command and the B.O.A.C., and as military needs diminish some of the Command's services are likely to be handed over to the British Overseas Airways Corporation.

The Future of Brooklands

AT the ninth annual meeting of Brooklands (Weybridge), Ltd., held recently in London, the sale of the Brooklands racing track to Vickers-Armstrongs, Ltd., for the sum of £330,000 was approved. In a statement circulated with the report and accounts of the company, and in his speech, Mr. C. W. Hayward, the chairman, said that during the period of the war the company's land and most of the buildings were under requisition by the Ministry of Aircraft Production for Vickers-Armstrongs, Ltd., and many new buildings were erected on the motor track, and the adjacent land. Much of the banking was cut through and other parts of the banking and the track were removed, while the remaining track was in a very bad condition. To restore Brooklands to its original condition, even if that were possible, would have cost a great deal, and in these times of difficulty with labour and materials, it would have been a very long time before the track could be made ready for reopening. After negotiations, to which the Ministry of Aircraft Production was a party, an offer was received from Vickers-Armstrongs, Ltd., to purchase for the sum of £330,000 the company's freehold land and buildings, and the benefit of all leases and tenancies. Vickers-Armstrongs, Ltd., also acquired the benefit of the company's claim for compensation arising out of the requisitioning. The price named, Mr. Hayward went on to say, was only achieved after long and difficult negotiations, and was one which might be regarded in all circumstances as very satisfactory, and in the best interests of all concerned. The closing down of this world-famous racing track was to be regretted.

Three Railway Accidents

ON the last day of December three people were killed and several injured when a Baker Street to Aylesbury train on the Metropolitan line ran into the rear of a Watford train, which was standing at a signal at Northwood Hills, Middlesex. The collision took place in the fog on an embankment near a bridge running over a side road. The front of the engine of the Aylesbury train was damaged and two coaches of the Watford train were telescoped and the centre compartments were burnt out. On New year's Day twenty persons were killed and several injured in an accident which occurred about 7.10 p.m., when the 2.50 p.m. fish train from Fleetwood to London ran into the rear of the 6.8 p.m. passenger train from Stafford to Nuneaton, which was standing in the Trent Valley (L.M.S.) Station, Lichfield, and loading and unloading passengers. The four coaches of the local train were smashed to pieces, one coach being thrown on to the platform and the three others pushed down the line. Ten persons were killed and many injured early on Saturday morning, January 5th, when the 11.15 p.m. sleeper express from King's Cross to Newcastle crashed into derailed goods wagons near Ferryhill Station on the L.N.E.R. main line, not far from Durham. It appears that the wagons of a goods train proceeding down an incline had become divided, and the rear trucks overtook and crashed into the front portion of the goods train which had been halted, strewing wreckage over the lines. Before any warning could be given the oncoming express ran into the *débris*, and the engine and ten of the coaches were derailed and a signal cabin was partly wrecked. The four leading coaches piled up, but in the rear part of the train little shock was felt. The driver of the express and his fireman escaped from their upturned engine with but minor injuries. Official inquiries are being made by the railway inspection department of the Ministry of War Transport into the causes of all these accidents.

The Port of London Authority

ON Thursday, January 3rd, Sir John Anderson was unanimously elected Chairman and Sir Douglas Ritchie Vice-Chairman of the Port of London Authority. Mr. Thomas Wiles, who assumed the chairmanship in 1941 for the duration of the war, now retires, and the Authority has placed on record its high appreciation of his valuable services. Sir Douglas Ritchie succeeds Mr. L. H. Bolton, who has resigned owing to business commitments. He, too, has received the warm thanks of the Authority. In its annual report, the Port of London Authority states that the port has survived the biggest crisis in its long history. Its value to the country made it a priority target for enemy attack, but it continued to operate throughout the whole period of the war. It played a major part, the report recalls, in the preparations for the invasion of the Continent. Various sites were set apart for secret work. Three-quarters of the "Mulberry" port concrete work was built on Thamesside and in the Authority's docks. Lend-lease weapons, materials of all kinds, and foodstuffs arrived in ever-increasing quantities, while special provisions were made for loading military traffic. Special roads were built, "hards" were constructed for vehicles, and ramps were cut into the quay walls. In the D-day armada there were no less than 204 ships and coasters from London, of which 194 had been loaded in the docks and dispersed to various points in the river to await sailing instructions. These ships carried 79,479 tons of ammunition, military stores and petrol, in addition to 6767 military vehicles.

Gauge and Toolmakers' Exhibition

THE Gauge and Toolmakers' Exhibition was officially opened on Monday, January 7th, by Mr. John Wilmot, the Minister of Supply and Aircraft Production. The Minister congratulated the exhibitors upon the high standard of accuracy attained by their products, and expressed his belief that the Exhibition showed that this country had lost nothing of its native skill, and, in fact, it might even have been improved upon. Our engineering achievements during the war were a proud testimonial to that skill, and it was time to show the world that it was no accident that produced the "Mulberry" harbour. The lesson should be driven home that the brilliant technical skill which produced the "Spitfire," the "Mosquito," and the "Lancaster," was not the last flash of genius from a decadent race, but rather it was that the situation in which we found ourselves gave us inspiration. A considerable part of the new Britain would have its foundation in the work of the gauge and tool makers who held the keys of production in their hands. Those keys must be used to unlock the gate which would lead to a bigger production and the greater export trade upon which prosperity must be founded. Mr. Wilmot reminded his listeners of the time before the war when this country—and, indeed, most of the world—was largely dependent upon certain German optical measuring instruments. When supplies were cut off, British firms had produced equal, and in some cases even better, instruments. He believed that prior to the war half of our fine measuring tools, such as micrometers and verniers, had come from abroad. By a phenomenal expansion, the industry of this country was able to provide in excess of 95 per cent. of the wartime requirements for those types of tools.

Technical Achievements in the Navy

(By our Naval Correspondent)

No. II—*(Continued from page 16, January 4th)*

Fleet Train Service to the Fleet Air Arm

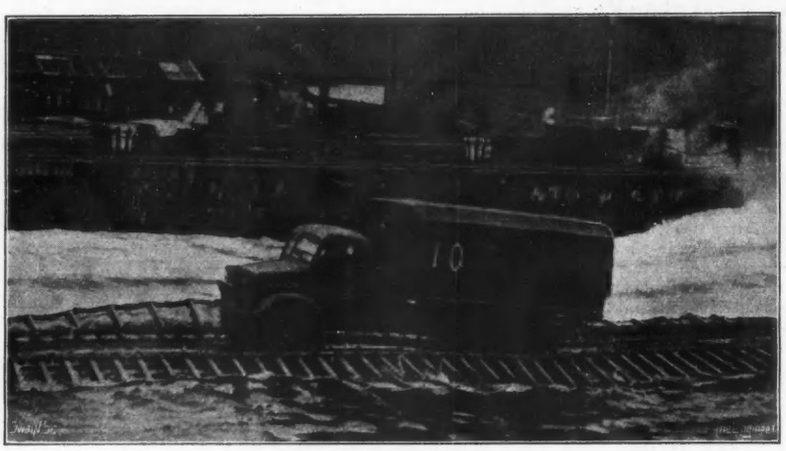
THE air component of the striking fleet, of course, required considerable replacement of aircraft and upkeep through the medium of the Fleet Train. Aircraft replacements were brought to the forward areas by escort aircraft carriers, of which two were allocated to the Fleet Train. The replacement aircraft could, of course, be flown off the escort aircraft carriers and land on the flight decks of the operational fleet aircraft carriers.

This, however, was but a part of the work of the Fleet Train on behalf of the Fleet Air Arm. There were in the Fleet Train two Fleet Air Arm maintenance groups, and each of these groups was composed of three highly specialised ships. In the first place, there was an aircraft maintenance ship, which was a converted light fleet aircraft carrier. This type of ship carried out all the small refits and short-term overhauls for the operational aircraft. The other two ships of the Fleet Air Arm maintenance group were converted 10,000-ton merchant ships. One of them dealt with air frame and aircraft component repair, overhaul, and refit. The other dealt exclusively with aircraft engines. These two vessels between them were, in fact, capable of effecting long-term overhauls of aircraft, while the converted light fleet carrier dealt with the short-term commitments of the aircraft as a whole. The conversion of the ships to fulfil these special *rôles* involved many interesting and novel problems in ship design. It was found, for instance, that the aircraft engine repair ships had to be specially lagged against noise, for the almost continuous testing of aircraft engines on the upper deck brought all on board to the verge of lunacy!

Mobile Naval Base

The Fleet Train comprised many other types of vessel, from big fleet tugs to floating docks; so-called "amenity ships," containing cinemas and brewery installations; hospital ships; salvage ships; and so on. A great many of these vessels were, of course, in that part of the Fleet Train which was not ordered to meet the fleet at sea in the forward operational areas, but which formed what might be termed the "mobile naval base" component of the Train.

In this component the difficulty was always to ensure a sufficient supply of harbour craft to deal with the enormous commitments which were likely to arise at short notice if the fleet came into harbour to replenish with fuel, ammunition, stores, victuals, and everything else in the minimum of time. The requirements for harbour craft were aggravated by the size of the open anchorages often used, and by their exposure to the weather. The fleet anchorage at Manus, Bismarck Archipelago, for instance, is 40 miles long by 10 miles wide, and there is little shelter from wind and sea. On one occasion the entire British Pacific Fleet arrived at Manus to be refuelled, reammunitioned, restored, revictualled, and made ready for sea in a hurry, there being another major operation in view. The ships were practically empty of everything when they arrived, yet the whole task was carried out in four days.



"SWISS ROLL" FLOATING PIER

The magnitude of this feat can only be appreciated when one realises the difficulties. To instance but a few of them, battleships do not like going alongside 10,000-ton supply ships and 10,000-ton supply ships do not like going alongside battleships, simply because the two types of ships behave quite differently in various states of wind and weather. This fact always added to the other difficulty—the provision of sufficient small craft for emergency harbour use. To some extent, this was overcome by taking up and by building large numbers of motor fishing craft. Some of the larger types, 90ft. and 70ft. in length, which were built in Australia, made the voyage up to the main British Pacific Fleet base at Manus under their own power. Large numbers of other harbour craft, however, had to be shipped to the places where they were likely to be required at short notice. This, of course, demanded the use of ships fitted with special heavy hoisting gear.

Enough has been said of the composition and the work of the Fleet Train to demonstrate the scale of the undertaking of providing the vessels and the enormous task of operating its units over distances of many thousands of miles in such a way that the right types of ships with the right supplies should always arrive at the right place at the right time, so that the fighting fleet should want for nothing.

Other Notable Developments

Most of the other naval developments which became known during the year are to a greater or lesser extent developments of former techniques which could reasonably be expected. An exception, however, is provided by floating roadways and aerodromes.

The first development of the discovery which made them possible was the riding of a motor cycle across a river over a strip of canvas stretched upon the surface of the water. From this practical demonstration, it was but a step to the production of floating canvas piers, which could be rolled up and carried without undue inconvenience by ships. This floating canvas pier was aptly called the "Swiss Roll," and it was found that under a tension of 18 to 30 tons a heavily laden lorry could cross this floating canvas pier from ship to shore. Some 2700ft. of "Swiss Roll" were in continual use during the invasion operations off the Normandy beachheads.

In the floating aerodrome a flexible artificial surface is provided by a number of hexagonal buoyancy cans linked together in such a way as to give great flexibility. From the similarity of these buoyancy cans to the leaves of a water lily, this floating naval aerodrome was given the name of "Lily"—an illustration appears in a Supplement to this issue.

An experimental "Lily" air strip was actually constructed by the Royal Navy and used by aircraft. This "Lily" was 520ft. long and 60ft. wide, and on this an aircraft laden to a weight of 9000 lb., has successfully landed and taken off. The simplicity of the flexible linking arrangements of the buoyancy cans is shown by the fact that a strip of this size can be assembled by forty men in one hour. The buoyancy cans used in this instance were 6ft. across and 30in. deep, but there seems little reason why their depth should not be scaled up in order to allow of a "Lily" supporting greatly increased weights.

Operation "Deadlight"

Perhaps the most important "naval occasion" of the concluding weeks of the year was the beginning of "Operation Deadlight," which is concerned with the conveyance of 110 surrendered German U-boats out into the Atlantic and their destruction in deep water. It is a long and tedious business which will take considerable time, but some portion of the duty is being used to provide training for guns' crews and for air crews of the Fleet Air Arm and Coastal Command of the Royal Air Force.

Some details of a few of the new anti-submarine weapons which played their part in the defeat of the U-boats on the ocean trade routes have recently been given—see THE ENGINEER, November 9th, 16th, and 23rd, 1945. It is interesting to compare the capabilities of these weapons with the capabilities of the newer types of U-boats now being destroyed. The two anti-U-boat weapons described were the "Hedgehog" and the "Sono-buoy." The former was a device which enabled charges somewhat similar to depth charges to be fired a certain distance ahead of the hunting ship. This eliminated the "blind" period of an asdic attack, for the asdic cannot maintain touch with a U-boat within some 60 yards, and to this distance must be added the length of the vessel attacking, since before the coming of the "Hedgehog" depth charges were always dropped or thrown from the stern of the asdic hunting vessel. This obviously called for some form of protective measure by the

Germans, and this they provided to a considerable degree by greatly increasing the maximum underwater speed of the U-boats, thus increasing their capabilities of dodging and escaping an attack, while leaving behind them a "false echo" in the shape of a patch of disturbed water.

The "Sono-buoy" was a buoy which could be dropped by parachute from aircraft. Once in the water a wireless antennae rose from the body of the buoy, while a hydrophone was lowered below the buoy. By automatic wireless, the sounds picked up by the hydrophone below water were relayed by wireless to ships and aircraft in the vicinity.

Here was a development which clearly called for a greater degree of silence in the U-boats, even when not actually attacking, and the German reaction to this requirement is to be found in the fact that in the newer types of U-boat every single item of machinery, even including the small emergency hand pump, is mounted on very thick rubber mountings. The more one studies the newer of the German U-boats, the more one is struck by the fact that almost all of the German developments were defensive in character, and dictated by our offensive weapons and tactics. Moreover, one is impressed by the strain which meeting these ever-increasing requirements must have laid upon the German economy and shipbuilding industries.

Coal in 1945

By Sir RICHARD REDMAYNE, K.C.B.

No. II—(*Continued from page 5, January 4th*)

The Report of the Technical Advisory Committee

ON March 14th, 1945, the committee of seven outstanding mining technicians appointed in September, 1944, submitted its report to the Minister of Fuel and Power, a remarkable accomplishment in view of the extent of the ground covered by and the detailed nature of the report. This is the second time in the history of the industry that a report of this character—relating to the technique of coal mining—has been issued by Government, a similar course having been adopted in 1908 by the Royal Commission on Mines, when a small committee was appointed to inquire into the causes and means of preventing accidents from falls of ground, underground haulage, and in shafts.

As the Reid Report—as it has become known from the name of the Chairman of the Committee—is the outcome of the careful investigations and views of seven distinguished experts in British coal mining, the conclusions arrived at ought to command the respect and most careful consideration of all who are interested in the future well-being of the coal mining industry of this country.

Naturally, some of the report is of an elementary character, as in all reasonably progressive undertakings, many of the recommendations have been standard practice for years nor has the management, except in rare instances, been restrained by directors from carrying into effect the necessary improvements forthcoming from the march of time and so bringing the collieries into line with the best modern practice. Each case—each separate colliery undertaking—ought, from the point of view of possible improvement in technique, to be considered on its merits, especially in regard to mechanisation. To indulge in sweeping generalisations, as some critics have done, in regard to the subject of reorganisation of the industry generally and to lay down conditions as applicable to all collieries, is not only unsound—indeed, foolish—but is liable to defeat the object sought, namely, the carrying into effect of more efficient mining. The Reid Report should be read in the light of this overruling caveat, with which view, I feel sure, the authors of that Report would be the first to agree.

It must be remembered that in instituting comparisons with the mining methods adopted and the results obtained in certain foreign coalfields, *e.g.*, America, Holland, and the Ruhr, the inference being that their better results are due to better technique, there are other factors to be taken into account, as, for instance, geological, age of undertaking, and number of the collieries included in the comparison; for a comparison to be of real value it must be a comparison of like with like.

The chief of the changes advocated in the Report is perhaps that in respect of the main haulage systems at our collieries—that we should adopt either locomotive haulage or transport by conveyors—the introduction of the electric trolley system would necessitate an alteration of the General Regulations. But, as was stated in a leading article on "The Technique of Coal Mining," in THE ENGINEER of April 13th last, "The determining question to be answered in respect of any given case . . . must be, does the haulage system in operation thereat wait upon the coal face for supply?" If it does, then no change is necessary in "the system" in that case. If, however, the production of coal at the face can be increased, the haulage system in operation should be such as adequately to meet the projected increase. Again, in regard to methods of working, as also stated in the same leading article, "For the attainment of the highest productivity the intensive room and pillar system as practised in the United States is advocated," but, as was pointed out, it is a somewhat wasteful method of working. As the "second choice" the Committee assign the longwall "retreating" system in contradistinction to the longwall "advancing" system, so largely in operation in British coal mining, but in the United States of America the retreating system with 100 per cent. extraction, one learns from later information, is being rapidly replaced by the more wasteful (in point of extraction) system of "stoop and room," owing to the expense of roof control in the former method. It is learnt, too, from recent reports, that at very few, if at any, mines, where banded seams are being worked in the United States (a characteristic of many British collieries), neither is there (*a*) complete extraction nor (*b*) is the coal cleanly produced in the mine by the band being left underground. In America they would send everything—dirt and coal alike—to the surface, the practice being to clean the coal there in preference to underground sorting. In Alabama, where thin seams (*e.g.*, some as thin as 22in., but usually between 2ft. 6in. to 2ft. 8in. in thickness) are being worked, only 75 to 80 per cent. of the coal available is being extracted, as against full extraction in similar cases in Great Britain.

The Report recommends that "skip-winding"—that is, the substitution of skips in place of tubs in cages, the latter being the general practice for the conveyance of coal to the surface at British collieries—should be much more widely practised at our collieries. This would, of course, necessitate the provision at the shaft bottom of a coal storage to allow of the automatic loading of the skip. The arrangement is such as has been operative in nearly all metalliferous mines throughout the world for many years and is undoubtedly conducive to saving in manpower, but in the case of coal is attended with certain disadvantages, such as increased breakage of the coal—though this is not always a deterrent (*e.g.*, in the case of coking and gas coals) and the increase of coal dust in the mine.

The Koepe system of winding, the "possibilities" of which the Committee suggests, should be investigated—especially for deep mines—has for long been known to mining engineers, particularly the modification described as the "Whiting" system, which has been in operation for many years at the Red Jacket shaft of the Calumet and Hecla copper mine in Michigan, U.S.A., and at the Kimberley diamond mines in South Africa. It is a system admirably suited to winding from great depths, but there is this disadvantage, where mining has to be carried out from more than one level, that the position of the tension carriage which runs on a track has to be varied.

Much misconception exists in the public mind as to the extent of the cost which would be entailed in carrying into effect the recommendations of the Committee. Wisely, the Committee itself does not state a figure. Personally, I do not believe that the expenditure would approach anything like the extravagant figures which have been quoted in the Press from time to time. Our mines are far more highly mechanised than is commonly realised.

The Government and the Coal Mines

On May 29th, Major G. Lloyd George, the then Minister of Fuel and Power, stated in the House of Commons that the Government had decided to set up for the coal mines a central authority, to be appointed by the Minister of Fuel and Power, which would, subject to the Minister's general direction, "insist that the necessary measures are taken to provide such help and guidance as are useful." These measures would centre upon the proper development and efficient conduct of operations in each coalfield according to the best modern practice. Grouping of collieries would be carried through voluntarily, if possible, but otherwise by compulsion; but amalgamations would only be proposed if it was shown that there were clear advantages to the nation and the industry. The making and carrying out of these plans would be undertaken by the industry itself. The duty of the central authority would be to satisfy itself that the scope and effect of the plans conformed to national requirements. Free enterprise was to be preserved and it was to be safeguarded from political interference in its day-to-day management. The central authority would be entirely independent of the industry.

But in July the present Labour Government came into power, and, in the King's Speech on August 15th, it was stated that a Bill would be laid before Parliament to nationalise the coal mining industry as part of a concerted plan for the co-ordination of the fuel and power industries.

From the speeches by, and from the inter-

views he has had with the representatives of the colliery owners, Mr. Shinwell, the present Minister of Fuel and Power, it would appear that the colliery owners, who number many thousands, are to be fairly compensated for the loss of their property. They have decided to submit their case, regarding the amount of the global sum to be awarded to them by way of compensation, to arbitration.

On December 20th the Coal Industry Nationalisation Bill prepared by the Government was made public. A detailed analysis of this most important and revolutionary measure would be too long for inclusion in this article, but the more striking of the proposals may be briefly referred to.

With regard to assessment of the amount of the global sum to be awarded by way of compensation to the owners of the mines, this is to be settled by a tribunal composed of two judges of the High Court (appointed by the Lord Chancellor) and an accountant, to be agreed between the two parties (*i.e.*, the Government and the Mining Association of Great Britain) or, in default of agreement, to be nominated by the President of the Institution of Chartered Accountants. The sum decided upon will be apportioned to each coalfield or district. The task of valuing the 850 separate undertakings will be carried out by District Valuation Boards, broadly in accord with the practice followed in the case of the transference of minerals to the Coal Commission. The apportionment of the global sum as between districts will be decided by a Central Valuation Board. The basis on which the valuation of the undertakings is to be made is that as between a willing buyer and a willing seller in the open market. Payment of compensation is to be made in Government stock and certain restrictions are imposed upon the disposal of the stock. It is estimated that it will take two years to assess the value of the mines.

A National Coal Board of nine persons is to be established for the management of the industry and to secure its efficient development. Appointment to this Board will be made by the Minister of Fuel and Power. It will work as a business corporation and be free from the Civil Service, but the Minister will have power to give it directions of a general character in regard to matters affecting the public interest. The capital requirements of the Board for the first five years are to be met by a sum up to £150 millions, to be advanced by the Minister, and subsequently as Parliament may determine. In addition, the Board is to have power to borrow temporarily up to £10 million.

Two Consumers' Councils, industrial and domestic, are to be set up to advise the Minister on matters affecting the sale and supply of coal.

It is understood that the two judges, one of whom will be Chairman, constituting—with the accountant—the tribunal to assess the extent of the compensation, will be Lord Greene and Mr. Justice Cohen.

The Gas Industry

It is notable that in the report of the committee of inquiry in regard to the gas industry—which Major Lloyd George set up when Minister of Fuel and Power in June, 1944—published on December 5th, 1945 (in which State purchase is recommended), it is advocated that that industry should be managed by boards of directors, each board consisting of a chairman and six directors, the chairman and three others to be full-time working directors. They would be appointed by the Minister of Fuel and Power for initial periods of five years, subject to renewal for periods of three years.

Nationalisation of Coal Mines in France

In France, where, by Order dated December 13th, 1944, all the collieries in the Nord and the Pas de Calais coalfields were taken over by the State, a collective administration has, by a further decree, been set up comprising a directional board and a consultative committee—a sales comptoir had already been established in 1940.

It will be interesting to see how the French colliery organisation—known now under the title "Houllieres Nationalles du Nord et du Pas de Calais"—works out and how the production and financial results obtained compare with those when the collieries were carried on under a system of free enterprise.

Aeronautics in 1945

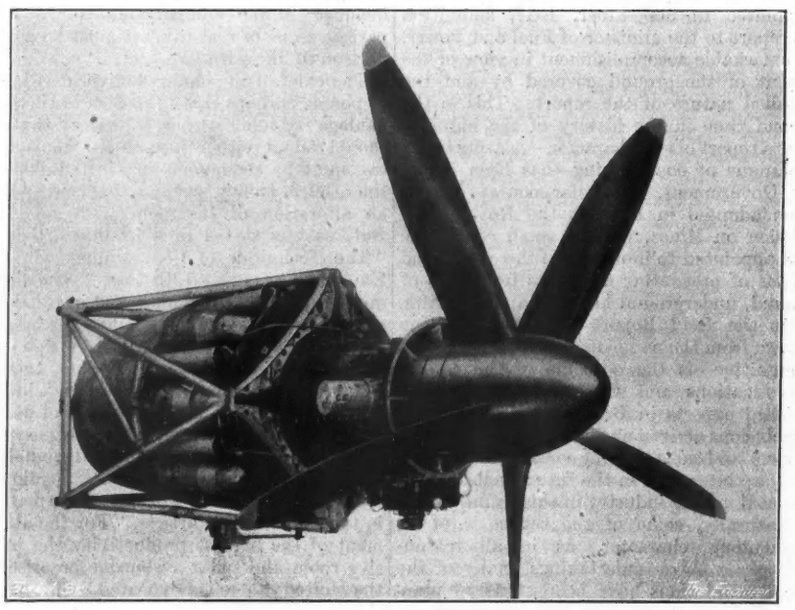
No. II—(*Continued from page 10, January 4th*)

Aero-Engines

IN the field of aeronautical power plants chief emphasis during the year was on the gas turbine. It would, of course, be premature to assert that the orthodox piston type of engine is a thing of the past. Its development still continues and there is no clear evidence that a limit to the power which may be developed in a single unit has yet been reached. In this country the power of the latest version of the Rolls-Royce "Merlin" engine has been pushed up to 2070 H.P., while the same manufacturer's "Griffon" engine is rated at 2300 H.P. A still more powerful British engine is the Bristol eighteen-cylinder air-cooled "Centaurus" engine, which develops 2500 H.P. These powers, however, cannot be regarded as approaching the maximum possible or practicable. From America has come the news that the Wright Company has produced a radial air-cooled engine rated at 3400 H.P. Even that figure may soon be surpassed by a French engine being built by the Matthis Company, which is said to be designed to develop 5000 H.P. in forty-two cylinders.

It seems, however, a reasonable prophecy that if the power developed in a single unit does not prove a decisive factor in the supercession of the piston engine by the gas turbine, that factor will be found in the relative degree of complexity and cost of production of the two types and perhaps equally in their relative frontal areas. A further consideration will be the relative costs of the fuels used. In these respects the gas turbine already has a lead over the piston engine, while its power output is certainly greater and is capable of being greatly increased without multiplying its complexity.

Of the British gas turbine units the Rolls-Royce "Derwent" jet engine attracted most attention during the year as a consequence of its being fitted in the record-breaking "Meteor" fighter. There is still some restriction upon the publication of information concerning this engine, specifically upon certain points of considerable technical interest. Some official test figures relating to the performance of the "Derwent" engine have been published. It should be noted, however, that the engine has been produced in five series. The test figures are, it would seem, applicable to the Series I engine, whereas the engines on the "Meteor" which secured the world's speed record of 606 m.p.h.—at, it is said, little more than cruising power—were of the Series V type. All that can be said concerning the Series V engines is that they develop about twice the thrust of the Series I engines. The official 100-hour type test of the Series I engine showed that with the turbine running at 16,400 to 16,600 r.p.m. the static thrust at sea level available for take-off was 1920–2000 lb. For cruising purposes with the engine running at 15,000 r.p.m. the sea-level static thrust was 1550 lb.



BRISTOL "THESEUS" GAS-TURBINE UNIT

It may therefore be assumed that during the record-breaking runs the Series V engines developed a static thrust of something over 3000 lb., which at 606 m.p.h. is equivalent to a power of about 5000 H.P., or 10,000 total H.P. for the two engines of the "Meteor." This figure provides an interesting commentary upon the price to be paid for speed in the air. The de Havilland "Hornet," said to be the fastest propeller-driven aircraft in the world, has two "Merlin" engines with a combined output of 4140 H.P. Its maximum speed is about 470 m.p.h. It would therefore appear that the last 136 m.p.h. of the "Meteor's" speed is achieved at the expense of some 5800 H.P.

The fuel used in the "Derwent" engine is aviation paraffin and the consumption amounts to 2360 lb. per hour when the engine is developing its maximum static thrust and 1820 lb. per hour at the cruising static thrust. These figures again relate to the Series I engine. Making no allowance for a probable improvement in efficiency, we can deduce from these figures that the consumption of fuel by the Series V engines during the "Meteor's" record-breaking trial was somewhere about $\frac{3}{4}$ lb. per horsepower-hour.

The de Havilland "Goblin" engine provides the power of the "Vampire" single-seater fighter. Like the "Derwent," it is designed to develop power by pure jet reaction. It has an overall diameter of 50in. and is designed to develop a sea level thrust of 3000 lb., which gives the "Vampire" in full fighting trim a speed of 540 m.p.h. These figures correspond with an output of 4320 H.P. The fuel consumption is stated to be 1·23 lb. per hour per pound of thrust, which is equivalent to a little over $\frac{3}{4}$ lb. per horsepower-hour. The engine has a total weight of 1500 lb., or not much more than $\frac{1}{3}$ lb. per horsepower. Another interesting item of information is the fact that at a speed of 10,200 r.p.m. the turbine delivers about 6000 H.P. to the compressor shaft.

Both the "Derwent" and the "Goblin" engines are pure jet reaction units, employing a gas turbine solely for driving an air compressor. Much attention has been devoted to an alternative method of employing a gas turbine for aircraft propulsion, namely, as a power unit coupled to a propeller with the turbine exhaust, delivered rearwards, serving merely as a secondary source of thrust. It is generally accepted that such a turbine-propeller combination would be more economical than a pure turbine jet unit at less than extreme heights and speeds.

The first propeller gas turbine power unit produced in this country is the Bristol 2000 H.P. "Theseus" I engine. This engine is a direct development of the work begun in 1924 by the Bristol Aeroplane Company on exhaust-driven turbo-superchargers. Such superchargers fitted to "Jupiter" engines were successfully flown at heights over 30,000ft., but for the time being their development had to be set aside in favour of gear-driven superchargers. In 1937 the company resumed work on exhaust turbines in conjuction with its sleeve-valve engines, but with the outbreak of war long-term research work on the subject had to be closed down. Later, however, when news was received of the progress made by Group-Captain Whittle's research the Bristol design staff began a prolonged study aimed at the production of a power unit consisting of an engine, a compressor, and an exhaust turbine. The engine was to be a gas turbine and was to be used solely for driving the compressor. The compressor was to deliver its output to combustion chambers fed with fuel—kerosene—and the products of combustion were to drive the engine. The products leaving the engine were to drive the exhaust turbine, which in turn was to drive a propeller through reduction gearing. In other words, the plant was to consist of the same three kinds of unit as those composing a normal exhaust-turbo supercharged engine set, but with the functions of the engine and the exhaust turbine interchanged. The engine and compressor were in effect to be simply a generator supplying gas to the exhaust turbine.

The "Theseus" I represents the first practical outcome of these ideas. The multi-stage compressor is of a combined axial and centrifugal type and draws in air through an annular entry surrounding the reduction gear. The compressed air is delivered rearward into a heat exchanger, from which it passes forward through a series of combustion chambers into which fuel is admitted. The products are led to a gas turbine driving the compressor and thereafter are exhausted to a separate exhaust gas turbine. This exhaust turbine is mounted on a shaft which passes forward to the gear-box through which the propeller is driven at a reduced speed. Leaving the exhaust turbine, the products pass to the heat exchanger, where they give up some of their heat to the air on its way from the compressor to the combustion chambers. From the heat exchanger the products are discharged rearwards through a controllable nozzle, thereby adding a certain amount of thrust to the pull of the propeller.

The unit has a dry weight of 2310 lb. It is designed especially for civil aircraft normally operating at heights of about 20,000ft. and at speeds near the 300 m.p.h. mark. Some further developments of gas turbine engine units are, it is understood, in hand at the Bristol works.

(To be continued)

British War Devices in 1945

No. I

THE engineer is always eager for up-to-date information on all points of engineering development, but in wartime many restraints have had to be put on this natural appetite. Now that our enemies are in defeat, the curtain of secrecy has been partially drawn aside. Throughout 1945 we have been able to give accounts of remarkable engineering achievements, brought to fruition in the forcing house of war in astonishingly few years. Though the average engineer is well aware that many novel ideas have been developed and put to use, it is only within the last few months that he has had access to the information without which he is unable to see clearly the amazing progress made in all fields of science and engineering.

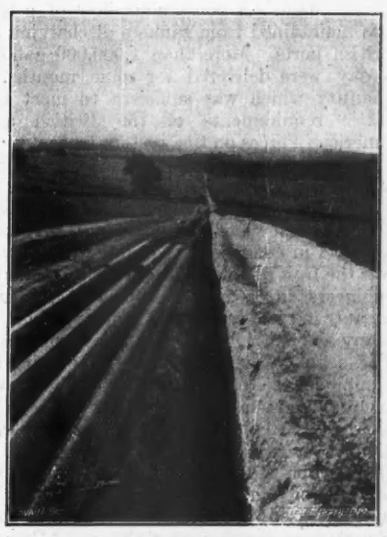
The flow of information has included official descriptions of many types released by the Service Departments, and also many papers and lectures, in most cases read before professional institutions by the scientists and engineers responsible for the work. All such important dissertations have found a place in these columns. In the review which follows we set forth the most striking points, making reference where possible to the articles wherein the full description appears.

Britain's Oil Pipe Lines

Early in the year, some months before release of information on the more spectacular "Pluto" development, it was learnt that we possessed an elaborate pipe line system more than a thousand miles long. Constructed to overcome the difficulty in handling enormous imports of petroleum required all over the country for war purposes, the pipe lines initially linked south-west and north-west ports with the London area. Later extensions covered the needs of our invasion Armies and Air Forces. Six months sufficed to complete the first part of the scheme, connecting the south-west ports with London, and this stage was in operation in December, 1941. The scheme went ahead until March, 1944, with extensions as dictated by the plan of war.

With the huge demand for steel for war purposes, the speed of laying was limited by the deliveries of pipe from the mills. The maximum laid in one week was 18 miles of 10in. pipe. The best sustained effort was 125 miles of mixed 10in. and 8in. pipe in eighty four days. More than half the system consists of 8in. pipe and more than a quarter of it of 10in. The working pressure was designed to be 600 lb. per square inch, enabling steel to be saved by using light-gauge pipe. Butt welding was impossible, due to lack of welders, and therefore special couplings were used.

The efficient construction of this network reflects much credit on the organisation, as difficulties were many. Plans were prepared by the Petroleum Department and carried



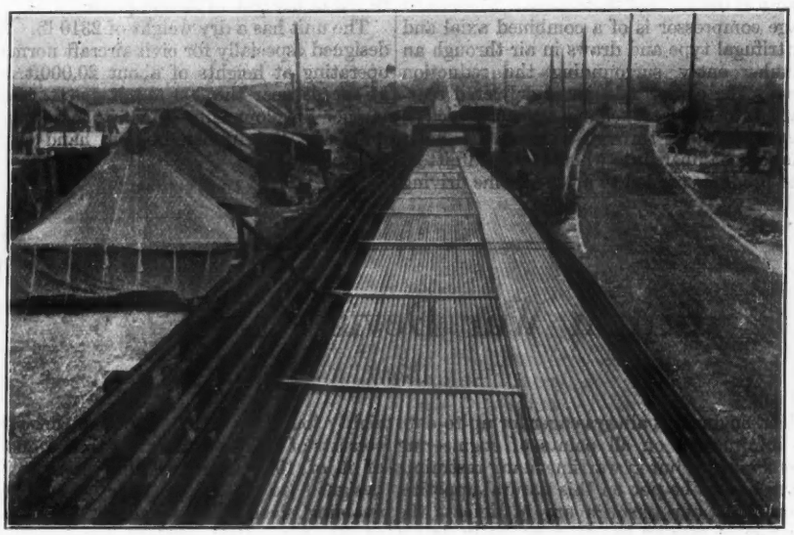
OIL PIPE LINE TRENCH

out by the Petroleum Board. For speed of construction, the work was divided into a number of equal sections, each with its own engineers, lands officer, labour force, and mechanical equipment. The allocation of materials as they became available proved the most critical job of all, and on this depended the equal progress of every part of the line.

"Pluto"

On May 24th the Petroleum Warfare Department released information concerning the successful accomplishment of "Operation Pluto" (pipe line under the ocean). This remarkable operation, entailing the laying and

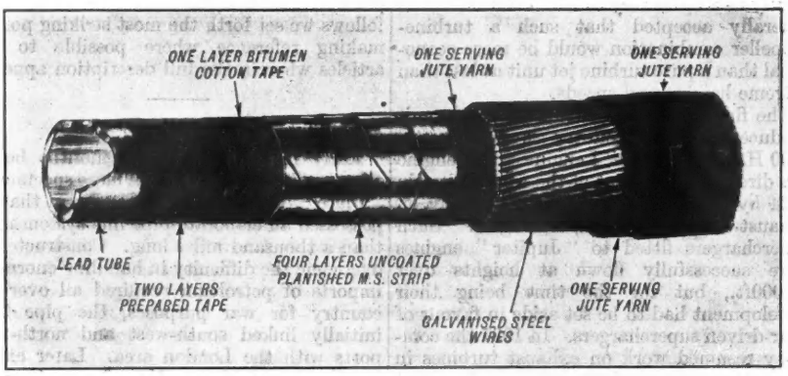
operation of a system of petrol pipe lines on the floor of the English Channel, consisting of twenty lines in all, was fully described in our issues of May 25th, June 1st, June 8th, and June 15th. Four lines were laid from the Isle of Wight to Cherbourg, the time for laying each line being about ten hours; for the shorter lines between Dungeness and Boulogne and across other parts of the Channel, about five hours was required. The lines were linked to the British pipe line system referred to above, and on the Continent to high-pressure lines extending through Belgium and Holland to the Rhine and beyond as far into Germany as Frankfort-on-Main. A continuous flow of petrol was maintained from tankers discharging at British ports. More than 1,000,000 gallons a day were delivered for some months, a quantity which was sufficient to meet the entire requirements of the British and American Forces on the western front.



STORAGE OF 4000-FT. PIPE LENGTHS FOR "PLUTO"

This immense engineering feat—it might almost be described as a fantastic feat, in view of the extraordinary equipment used and the great speed at which it was prepared and laid in conditions of complete secrecy—was the fruit of painstaking work by teams of engineers in several Government Departments, in the petroleum industry, and in many engineering and cable-making firms. For a full account of the system and its equipment the reader is referred to the above-mentioned issues of THE ENGINEER, as in this necessarily brief review adequate description is impossible. But we reproduce a photograph showing the storage of 4000ft. lengths of 3in. pipe for one of the two systems used, together with another, in a Supplement showing one of the great "Conun" drums, 90ft. wide and 50ft. overall diameter, on which a maximum of 70 miles of continuous pipe can be accommodated. Pipe lines for this system were welded from 20ft. lengths at a special factory at Tilbury, at the rate of 10 miles per day. Known as "H.A.M.E.L." pipe line, the name is derived from the surnames of Mr. H. A. Hammick, chief engineer of the Iraq Petroleum Company, and Mr. B. J. Ellis, chief oilfields engineer of the Burmah Oil Company, both of whom had been seconded by their companies to the Petroleum Department.

The other system was known as "H.A.I.S." pipe cable (Hartley, Anglo-Iranian, Siemens) and was named from Mr. A. C. Hartley, chief engineer of the Anglo-Iranian Oil Company and the firm of Siemens which was responsible for much of the development work. This system, no less ingenious, was actually the first to be proposed. A flexible pipe cable was laid from cable ships fitted with specially constructed cable-laying machinery. As a first step in developing this cable, two 30-mile lengths, made to a 2in. diameter design, were ordered for trials. No existing cable ship was large enough to carry a full length of this unusually heavy cable, and therefore a coaster, the ss. "London," was adapted and became the cable-layer H.M.S. "Holdfast." An experimental cable was laid by this ship across the Bristol Channel in December, 1942, with success. Little did consumers of petrol in North Devon and Cornwall realise that for more than a year their supplies had been pumped across from Swansea! Large supplies of H.A.I.S. cable were ordered when this test had proved the feasibility of the scheme. The original design was modified to provide increased capacity by increasing the diameter to 3in. and strengthening the cable for working pressures in excess of 1200 lb. per square inch. An accompanying engraving illustrates the construction of the cable, stripped to show its component parts. The internal lead sheath, through which the petrol flows, was manufactured in 700-yard lengths. It has an internal diameter of 3·05in. and a minimum thickness of 0·175in. The finished cable weighs, full of water, 63 tons per nautical mile (6080ft.). Couplings for this cable were of most ingenious design; they were fully described and illustrated in our articles.


ONE LAYER BITUMEN COTTON TAPE
ONE SERVING JUTE YARN
ONE SERVING JUTE YARN
LEAD TUBE
TWO LAYERS PREPARED TAPE
FOUR LAYERS UNCOATED PLANISHED M.S. STRIP
GALVANISED STEEL WIRES
ONE SERVING JUTE YARN

CONSTRUCTION OF H.A.I.S. PIPE-CABLE

"Fido"

Soon after the news of "Pluto," the Petroleum Warfare Department on June 1st, in a joint statement with Bomber Command, gave particulars of "Operation Fido," the development which solved the problem of landing aircraft on airfields in fog. The initials "F.I.D.O." originally stood for "Fog Investigation Dispersal Operations," but when the system proved a brilliant success, the Royal Air Force characteristically changed it to "Fog, Intensive, Dispersal Of." So effective was the system that the halting of the German offensive in the Ardennes in December, 1943, was attributed largely to the weight of Allied air attack, made possible by the ability to take off and land in dense fog. The "Fido" method of fog dispersal was operated with success from the winter of 1943 onwards.

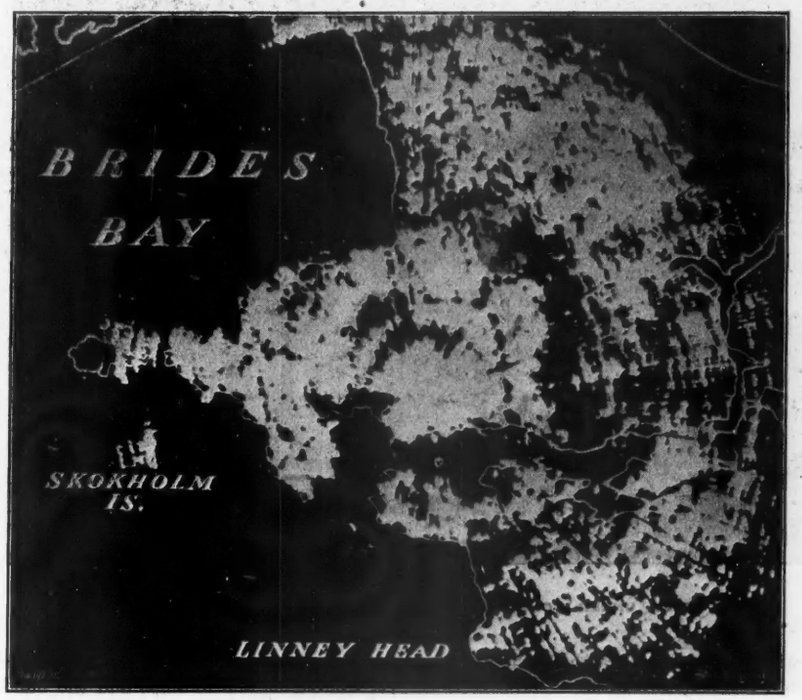
"FIDO" FOG-DISPERSAL SLOT BURNER

In our issues of June 8th, 15th, and 22nd, the experimental work leading up to the final design of the equipment was fully described and an account given of its operation and subsequent development. In tackling the problem, a review showed that means of dispersal all fell under the heading of either precipitation or evaporation of fog droplets. Eventually, it was decided that the most practical method was to evaporate the fog locally by means of direct air heating, and many forms of heater installations from coke braziers to atomised petrol spray apparatus were tried. Development work was carried out rapidly. "Haigas" and "Haigill" (Hartley Anglo-Iranian Gas and Hartley Anglo-Iranian Gill) were two varieties of burner which met with success. The last-

named type in its Mark V form was fitted to thirteen operational airfields.

One of the last types to be developed was the "Slot" burner, illustrated herewith, developed by a team led by Dr. Lander, at the City and Guilds Engineering College. Design considerations were that the burners should be below ground level, so as to offer no obstacle to aircraft and other traffic, and that the system was to be suitable for remote ignition and automatic control. A steel grid covers the burner. The actual burner is of the shape of a horizontal hairpin, in which flames from petrol vapour issuing from orifices in the lower limb impinge upon the upper limb and vaporise the petrol flowing through it. The burner is mounted in a trough of cast iron, supported, in turn, in a trough of heat-resisting concrete. The steel covering grids are calorised to make them heat-resisting. The whole installation is operated from a switchboard in a central control room. Many firms were associated with the experimental work in connection with "Fido" and in producing the Haigill, Hades, and Slot burners and pumping equipment, and the rapid development achieved, was in no small way attributable to this excellent engineering teamwork.

An illustration in a Supplement shows the "Fido" installation in operation at a bomber airfield. Plans were made to install fully automatic equipment at Heathrow airfield, the chief airport for London, and in our issue of October 26th we referred, under the heading "Centenary Exhibits at the Imperial College," to the proposed installation. Altogether there were to have been 12,000 yards of burners, capable of burning petrol when in full use at the rate of 1000 tons per hour. For economy, the burners were to split into forty-eight groups, capable of being operated independently and controlled from a central room. But "Fido" equipment is very expensive to operate—it is estimated, for instance, that it costs about £450 to land a large transport aircraft by its use—and it has since been announced that the "Fido" installation at Heathrow will be abandoned.



RADAR MAP AS SEEN BY A NIGHT BOMBER

"Swiss Roll" and "Lily"

Naval wartime developments of which particulars have been disclosed include the "Swiss Roll" floating pier, illustrated in use in an engraving, on page 28 and the "Lily" floating landing ship, a photograph of which is reproduced in our Supplement. These devices were described in THE ENGINEER of September 28th, 1945.

The "Swiss Roll," as its name implies, can be rolled up and carried on board ship until required for use. Though nearly twenty times as light as a "Bailey" bridge of equal length, it is capable of supporting a lorry weighing 9 tons, even in rough water. It is built from canvas and wood, and a tension of between 18 and 30 tons is applied to it. The support given to the vehicle traversing it is derived mainly from the water beneath it. Some 2700ft. of "Swiss Roll" were in continual use at the "Mulberry" harbour at Arromanches during the invasion of the Continent, and stood up to severe weather conditions.

The other device, the "Lily" landing strip, consists of large numbers of hexagonal buoyancy cans, 6ft. across and 30in. deep, flexibly linked together so as to "give" in a controlled manner to the motion of the sea. The cans are sufficiently small to be easily transportable, and since they can be rapidly pinned together, a floating "island" of any desired shape can be built. A "Lily" air strip, 2500ft. long, can be transported in three average merchant ships. Our Supplement illustration shows an experimental strip 520ft. long and 60ft. wide, laid by the Admiralty. On this strip aircraft laden to 9000 lb. were landed and taken off again. It is stated that such a strip can be assembled by forty men in an hour. The permissible load that can be carried is governed by the dimensions of the individual cans, and their size could be increased if it were desired to make a strip suitable for heavier aircraft.

Both these devices are based upon the inventions of Mr. R. M. Hamilton, of Victoria Street, London, S.W.1, for whom the necessary mathematical calculations were performed by Mr. J. S. Herbert, a housemaster at Eton College.

Radar

Apart from the atomic bomb, probably the most useful single development contributing to the final victory was Radar. Here, again, is a field so wide that it is impossible to do justice to it in this brief review. We can only point to the expositions which were released for the first time during the past year, and which make the most absorbing reading. In four articles beginning in our issue of August 17th and continuing on August 24th and 31st, and September 7th, the history of Radar was set forth with an introductory statement by Sir Stafford Cripps, President of the Board of Trade and Chairman of the Radio Board, 1942–45. This statement was most appropriately released in the week of our total victory. This was the first time that the whole world had been allowed to know the story of Radar, its inception and development, and of its many uses by the Armed Forces. British scientists took a leading part in its development and application, as we now know. To the end, the Germans failed to overtake our lead in this department of applied science. As we stated in a leading article at the time, Radar was undoubtedly a trump card in our hand and those connected with its scientific development and its Service employment co-operated to play it brilliantly.

A further most interesting article, "Radar Countermeasures," appeared in our issue of December 7th, describing the amazing bluff and counterbluff of the Signals Directorate of the Air Ministry in the war of the ether. Enemy intelligence was reduced to chaos, particularly at the time of the invasion of the Continent.

(To be continued)

Civil Engineering in 1945

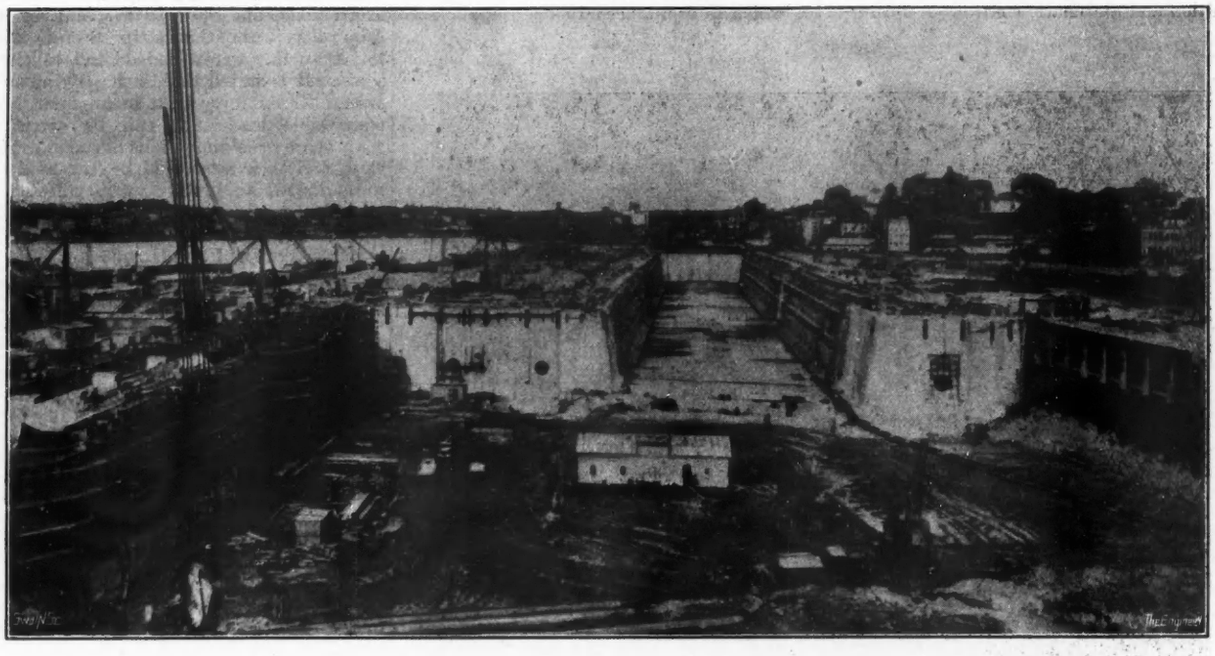
No. II—*(Continued from page 22, January 4th)*

Sydney Dock

THE Sydney dock, the second of the two large docks mentioned in this article last week, was opened by the Duke of Gloucester on March 25th and named "The Captain Cook Graving Dock" by the Duchess of Gloucester. The site in Sydney harbour lies between the mainland and Garden Island, the naval headquarters in Sydney. It was chosen after an investigation of about ten possible sites in Australia made during 1939. Work was commenced on the dock by the beginning of 1941 and the fall of Singapore made its completion a matter of extreme urgency. The site chosen necessitated the enclosing of about 30 acres between the mainland and Garden Island, with a depth

of water over the area up to 50ft. This area was successfully reclaimed by cofferdams and dewatered in March, 1942; concrete construction on the dock proper began in November, 1942. The dock as completed measures 1177ft. in length by 152ft. between copes, with a depth over the sill of 40ft. 6in. at low water spring tides, and can thus take the largest capital ships. It is subdivided by an intermediate caisson groove so as to provide an inner section about 700ft. long and an outer section 350ft. long, thus permitting cruisers and destroyers to be docked at the same time. The dock entrance can be sealed off by a floating ship type caisson. The pump house and other buildings containing essential equipment are all underground within bombproof structures. The graving dock has been designed to be suitable for the largest commercial vessels of the "Queen Mary" class and the necessary additional facilities, including increased heights of cranes, have been provided for this purpose. Ancillary works consist of a large workshop, together with a fitting-out wharf, on which a 250-ton hammer-head crane is at present under construction. The total cost of the scheme will probably amount to nearly £A10,000,000. The consulting engineers for the scheme were Sir Alexander Gibb and Partners, of Westminster, who dealt with the whole of the design and also assisted the Commonwealth authorities in the supervision of the construction work at the site. Most of the work was carried out by State Departments.

Since the dock was opened in March, 1945, it has been in constant use and a considerable proportion of the large battleships and aircraft carriers of the British Pacific Fleet have made use of its facilities.

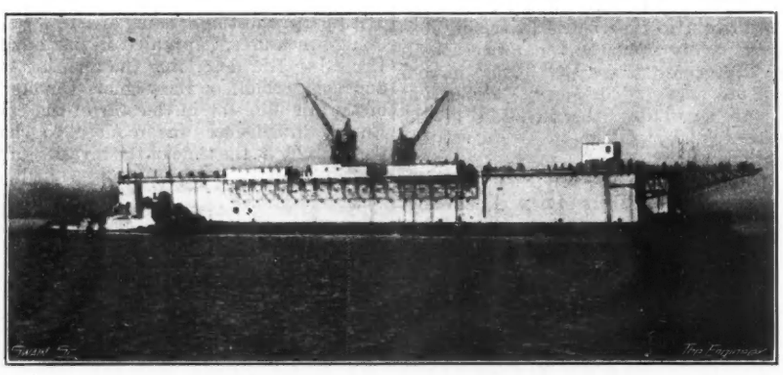


SYDNEY DOCK UNDER CONSTRUCTION

Durban Floating Dock

Another dock worthy of mention in this review of 1945 is a floating dock completed during the year at Durban, South Africa. It is illustrated in an accompanying engraving and has a lifting capacity of 15,000 tons. Some 7000 tons of steel for this dock was obtained from this country and fabricated and assembled in South Africa. The dock was designed by Messrs. Clarke and Stansfield for the Admiralty and the contract for its construction was let to Dorman Long and Co., Ltd., of Middlesbrough, whose subsidiary, Dorman Long (Africa), Ltd., performed the actual building of the structure. Work was begun in June, 1943. In the absence of a suitable slipway, the dock was built within a large cofferdam at Durban. It is of interest to note that in order not to interfere with ship repair work at that time making heavy demands on the limited supply of labour, the firm undertook the training of new workers with such success that men in skilled repair work were never required for building the dock.

The new floating dock forms a part of a plan carried out in considerable secrecy to create a naval base at Durban by reclamation of sandbanks and swamps and the building of quays, warehouses, &c., on Salisbury Island. Little information is at present available regarding this work, but an accompanying illustration shows the new base; which is reported to have cost £2,000,000.

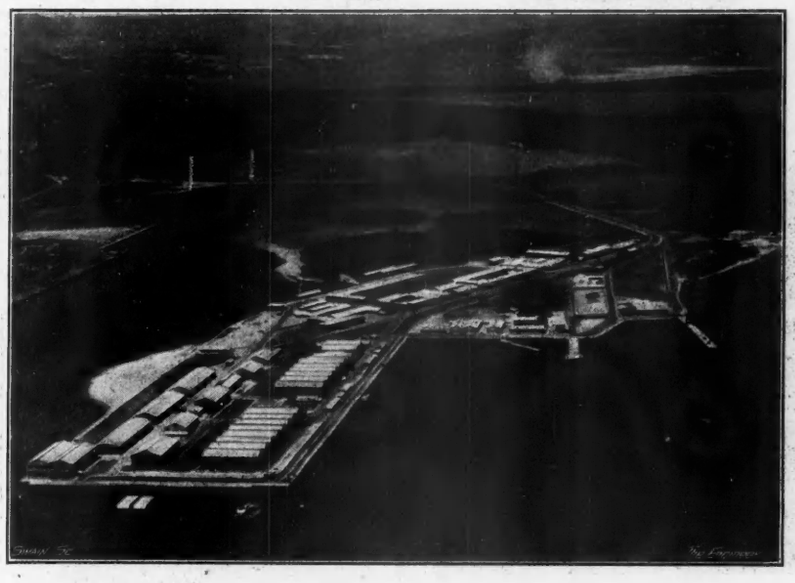


DURBAN FLOATING DOCK

Western Europe

Of Western European countries within whose borders the German and Allied armies fought, Belgium seems to have recovered more quickly than any other, probably because liberation, when it came, was very swift, so that there was little time for sabotage. Her chief port, Antwerp, survived unscathed, though the city itself was severely damaged by flying bombs and rockets. In Holland the Germans had time to do considerable damage, particularly by flooding. But before leaving the country the Canadian Army did much to clear canals and waterways of wreckage. Units for the construction of the Mulberry harbour at Avranches are now being used to close breaches in the dykes around the island of Walcheren, and certain polders in other parts of the country have already been drained. But many years must pass before areas flooded with salt water will again be under crops, and much rebuilding of towns, villages, and hamlets immersed for months under tidal waters will no doubt be necessary. France is still struggling to bring order out of the chaos that was left when the Germans retreated. The ingenuity of French engineers has already made possible many repairs to damaged bridges, the partial reinstatement of the high-tension power network, and the restoration of supplies from damaged hydro-electric works. An illustration in our Supplement shows the Pont de Vienne under reconstruction. Rail services are thus beginning to operate more normally

and, were it not for the fact that a dry season has depleted storage reservoirs hydro-electric power would be reaching the towns. But despite a rapidly rising output of coal, scarcity of that commodity is hampering the generation of power from steam stations. Germany, of the Western European nations, is in the worst plight of any. Here reconstruction is delayed, not only by interrupted transport systems and general disorganisation, but also by lack of decision amongst the Allies as to the policy to be pursued, particularly in such important industrial areas as the Ruhr and Rhineland. Progress is, however, being made and amongst works of some interest now under construction are certain bridges across the Rhine to replace those built by the Allied Armies during their advance, which, besides being unsuitable for more than temporary purposes, offer obstruction to navigation.



DURBAN NAVAL BASE

France

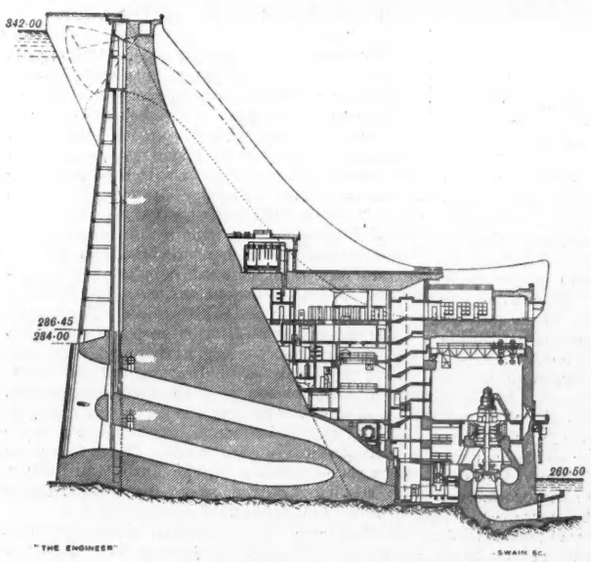
Despite difficulty in obtaining materials, work was proceeding in France during the year on two interesting dams. One across the River Dordogne forms part of a great project for the control of the river as it flows through a series of gorges. In all there will eventually be four dams, named respectively Bort, Mareges, L'Aigle, and Chastang. The reservoir formed by each dam will reach upstream as far as the toe of the dam above. Mareges dam is already in existence, L'Aigle dam is under construction, and the others are only projected. L'Aigle dam is a semi-arch structure, the thrust being partially resisted by arch action. Its machinery hall is placed at the toe of the dam and two spillways discharge over its roof. The dam has a height of 90m. and a length along the top of 290m., and at the normal maximum level of 342m. above datum it holds up 200,000,000 cubic metres of water, all but 40,000,000 cubic metres of which can be utilised on a drawdown to level 311m. above datum. Four turbine-driven alternators of 60,000 kVA capacity at 80m. head, each served by a 4m. diameter power conduit, have been installed. The two spillways over the dam are controlled each by two 12m. by 12m. gates. A section through the dam is reproduced on this page and an engraving in the Supplement shows work in progress at the site in February last year.

The other dam to which reference has been made is in the same area. The St. Etienne-Cantales dam lies athwart the River Cère, a tributary of the Dordogne, and in conjunction with the Lamativie and Laval de Cère dams downstream, completes the hydro-electric development of the river. Like the L'Aigle structure, it is curved in plan, some of the thrust being taken by arch action. Its plan too, is similar, in that the power-house is placed at the toe of the dam and the spillway discharge passes over its roof. A photograph of the dam under erection is reproduced in the Supplement, and a section through the structure on this page. The dam has a maximum height of 71m. and a developed length of 270m. Two generators are installed, each developing 25,000 kW, and a further one is to be installed later. Each turbine is served with water by a 4·15m. diameter steel-lined pressure conduit. This structure was fully described and illustrated in our issue of August 24th last.

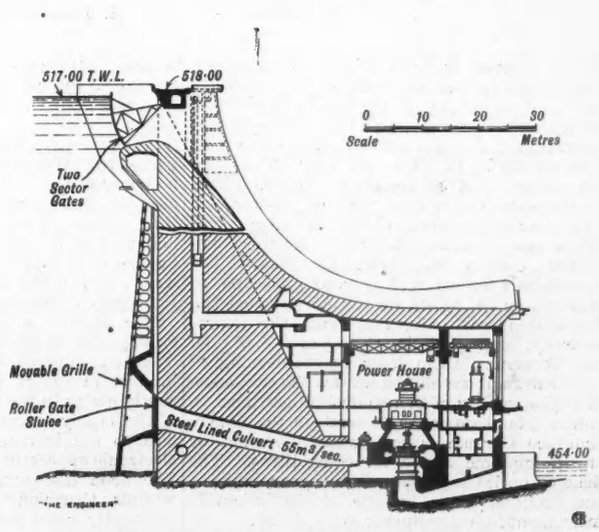
Work of quite another kind was proceeding during the year on the Kembs barrage across the Rhine. This barrage forms the first stage of a project for a "Grand Canal d'Alsace" for the improvement of navigation and the utilisation of the power of the Rhine rapids between Basle and Strasbourg. Included in the scheme is a canal more than 100 kiloms. long, planned to be completed in eight stages.

The Kembs barrage, which was in existence before the war, has five openings, each 30m. wide, separated by piers 5m. thick. Electric lifting gates operate in each opening. Normally water from the Rhine is diverted into a canal some 6 kiloms. long, 150m. wide, and 12m. deep, at the rate of 850 cubic metres per second. The canal forms a navigation channel as well as carrying the water to the headworks of an hydraulic power station. The power station is equipped with five vertical-spindle alternators, each 31,000 kVA capacity under a head of 16·60m. The resulting power is distributed at 150,000 volts to the East of France and at 220,000 volts to the Paris region.

These works suffered some damage in 1940, but were repaired and functioned normally until during the battle of Alsace, between November, 1944, and February, 1945, they suffered more serious destruction. Accompanying photographs reproduced, one on this page and one in the Supplement, show the scale of the damage to the barrage. Bombs were partly responsible, but the Germans, in evacuating the area also laid explosive charges. At the hydro-electric



SECTION THROUGH L'AIGLE DAM



SECTION THROUGH ST. ETIENNE—CANTALES DAM